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The Hill Building: Special Building Design for Special Use

The problems of designing a building for a particular specialized use were handled with unusual care and originality in the case of the new Hill Building, New York City, the present home of ENGINEERING NEWS, occupied only a few months ago. The Hill Publishing Co. was unable to find a building in New York City suited to the requirements of a large printing and editorial enterprise, and therefore proceeded to plan and construct such a building for itself.

Located in a new growing industrial quarter of the city, the region lying north of 34th St. and west of 9th Ave., the building secures the advantages of free exposure on all sides. By employing very large glass surfaces and an exterior of cream-colored mat-glazed terra cotta and buff brick, as well as by the orientation and arrangement of its ground plan, the building retains maximum advantages as to light. By exclusive reliance on artificial ventilation with air washed and humidified, and keeping all windows locked shut, the best atmospheric conditions are secured, to the advantage of the printing operations as well as to the benefit of the occupants. By the provision of great strength in the structure—for 300 lb. live-load per sq.ft. —ample capacity is secured for any service. By spacing the columns to suit the setting of printing machinery, quite out of accord with usual arrangements, a high space efficiency is attained. By the careful study of service requirements in the details of construction and equipment, followed by the creation of numerous articles and constructions not previously manufactured, the building is made throughout to correspond in efficiency with the space utilization.

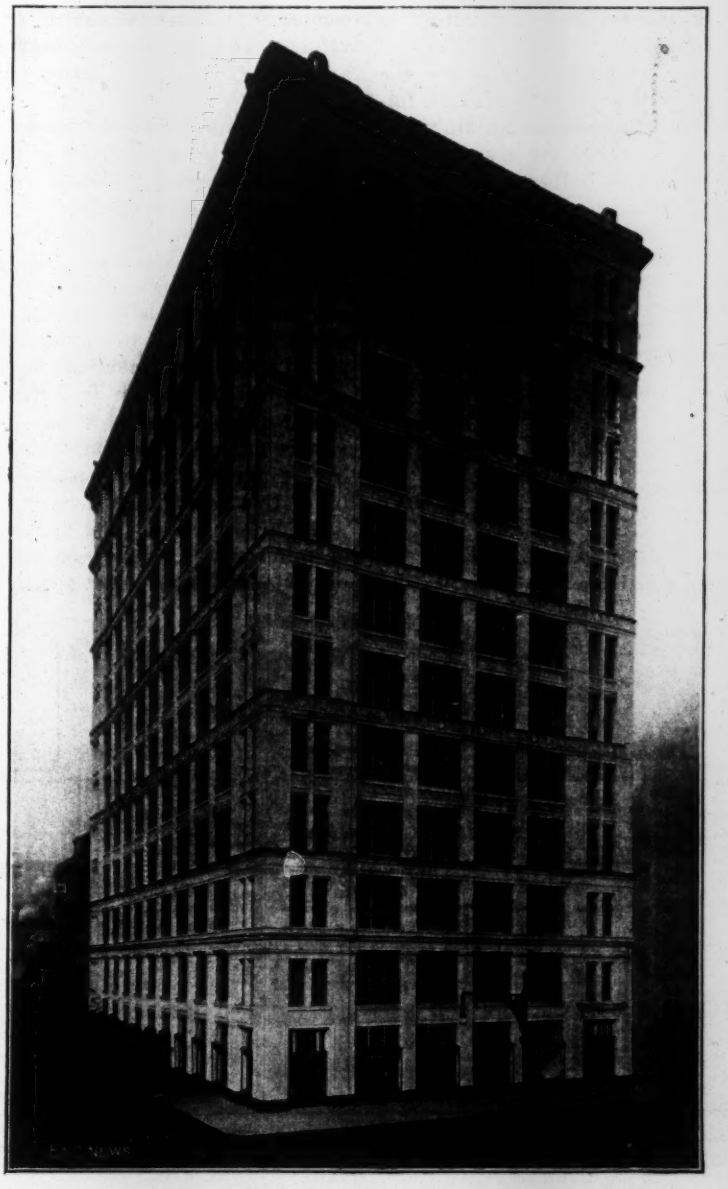


FIG. 1. THE COMPLETED HILL BUILDING, SPECIALLY DESIGNED FOR PRINTING AND EDITORIAL USE

Above all, the building is really fireproof. Except for exposure fires on the street fronts, no fire contingency can prove serious to either building or occupants. There is not a stick of wood in the structure, no wooden floors or sleepers, and no wooden window frames or sash. The windows (except on the streets) contain wire-glass. Doors are self-closing and present only asbestos-lined steel plate in integral steel frames. Vertical openings are inclosed. Even water damage through vertical openings is forestalled by dams at riser pipes, and by scuppers. Finally, the whole building is sprinkled. Therefore the lowest insurance rate in New York is secured—5.68c. per $100 on building, and 14c. on contents.

PLAN OF BUILDING

The building is roughly 99x175 ft. in plan, and has twelve stories and a mezzanine or gallery in the upper story. As the stories are materially

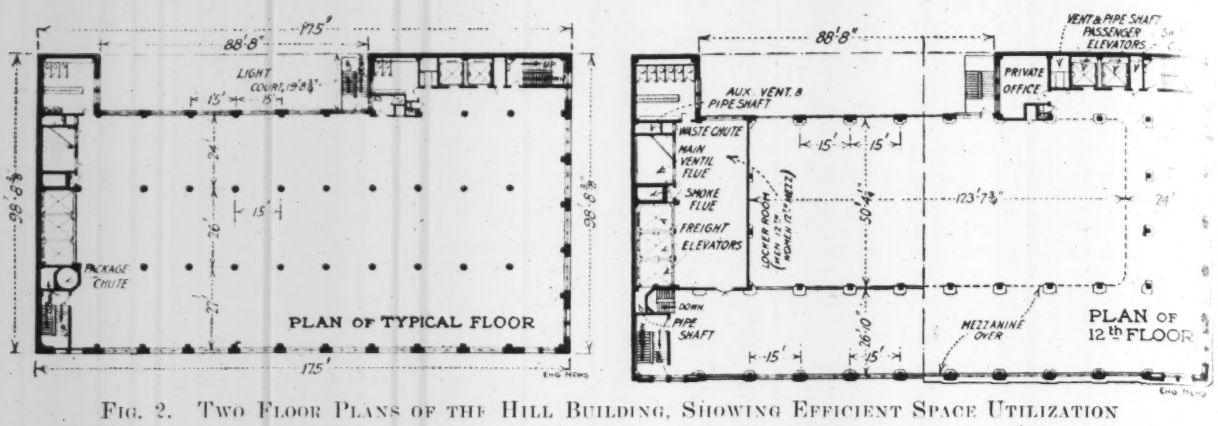


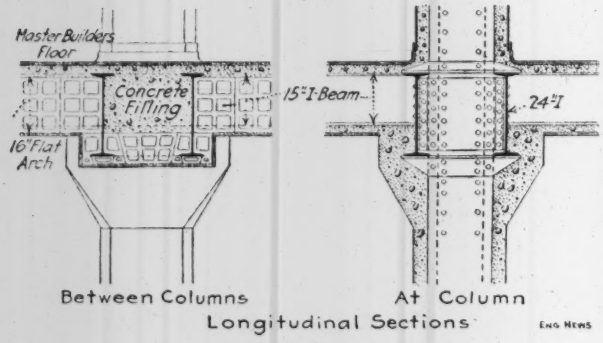
FIG. 2. TWO FLOOR PLANS OF THE HILL BUILDING, SHOWING EFFICIENT SPACE UTILIZATION

higher than is customary, being 16 ft. from floor to floor or about 14 ft. in the clear (the first story 16 ft. in the clear), the total height of the building from street to roof is no less than 206 ft.

The general plan of the building, with entrances at the diagonally opposite corners on the two street fronts, follows current practice in loft and warehouse building construction, but is worked out in detail for space utilization efficiency. By elimination of hallways at the elevator entrances, and by using the two wings at front and back of the court for service purposes (see plans, Fig. 2), the available working space of the floor is left in almost completely rectangular shape. The whole area is of full value because the window arrangement, the large glass area, and the exposed position of the building give excellent lighting all over.

As the building was designed for printing use, the governing item in occupancy was printing-press machinery. The column spacing was therefore made no wider than just enough to accommodate one press per panel. In place of the usual spacing of 20 to 24 ft., this building has panels sufficient for any probable width of press, and small enough to waste a minimum amount of space whatever size of press is installed. The longer dimension—which is transverse to the building, as presses are to be placed transversely, abutting on longitudinal gangways—ranges from 24 ft. 4 in. to 26 ft. 10 in.

The unequal lengths of bay represent one of the provisions against vibration. The different girder spans having different natural periods of vibration, it was believed that resonance effects could not occur as freely as with uniform spans. But to retain the desirable features of uniformity in column spacing, the spans are varied by only 2½ ft. from shortest to longest.



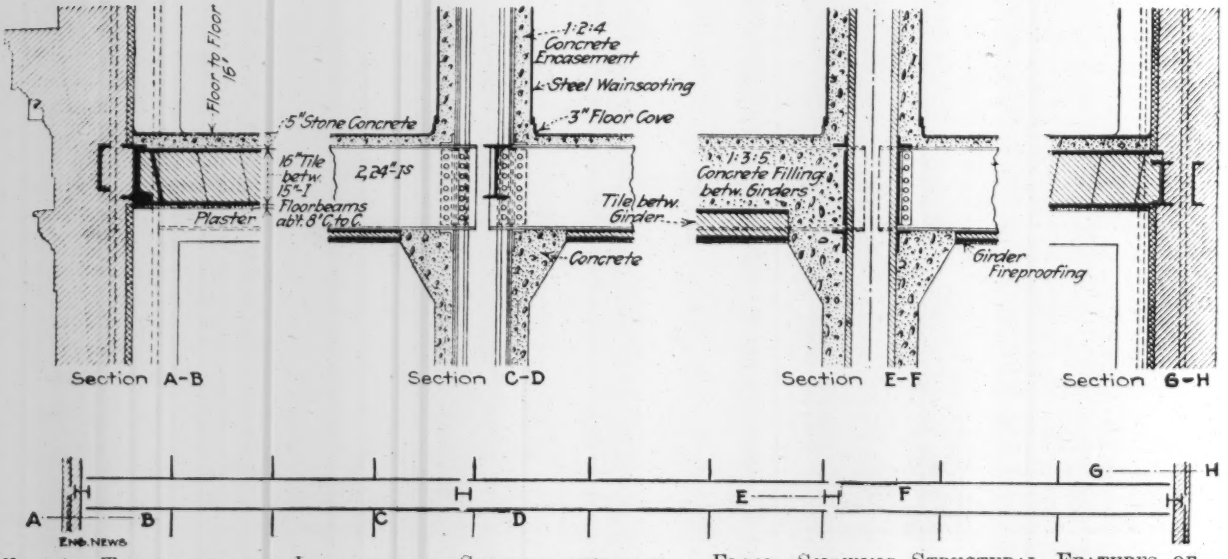


FIG. 3. TRANSVERSE AND LONGITUDINAL SECTIONS THROUGH A FLOOR, SHOWING STRUCTURAL FEATURES OF THE BUILDING

Freight-Entrance Driveway into Building

The rear entrance of the building is developed into a complete entrance and interior driveway, so that wagons can load and unload in the building, receive mail directly from the spiral mail chute, etc. The asphalt-block-paved driveway is at sidewalk level. Just at the driveway the sidewalk is sheltered by a steel-and-glass marquise, and it is over this marquise that the entrance opening for air for the ventilation system is located.

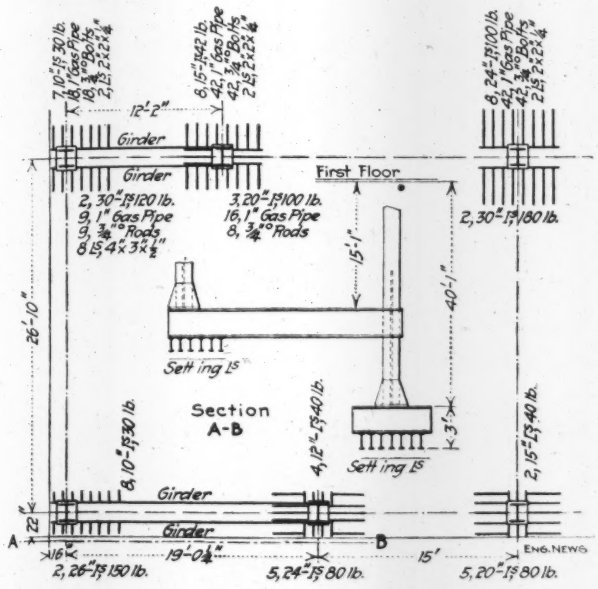


Fig. 4. Southwest Corner Grillages

Foundations and Framing

The site of the building had rock exposed nearly at ground surface. This fact limited the problems of subsurface construction and of foundations. There is a single basement story over the whole area of the building, with a sub-basement for the boiler room only.

The location of boiler room was determined in part by a deep pocket in the rock, going down some 50 ft. below curb; as this occurred at the west end, near the originally planned location of the boiler room, the latter was shifted to occupy the pocket. The same dip in the rock is also responsible for the fact that the foundations, which generally are simple grillage footings of small size to distribute the column loads from the cast bases to rock at the unit-pressure allowed by the Building Code, include a few concrete piers.

Fig. 4 sketches the footings at the southwest corner, including group footings on the building and typical interior footings.

Structure Very Massive

The steel frame of the building,* as well as the terra-cotta floor construction, is unusually heavy, on account of the high live-load of 300 lb. per sq.ft. The steel frame weighs slightly over 2 lb. per cu.ft. of contents. In spite of the heavy construction, columns of simple Bethlehem H-section were used throughout. In the lower stories,

*See an article on the erection of this frame, "Engineering News," Dec. 25, 1913, p. 1298.

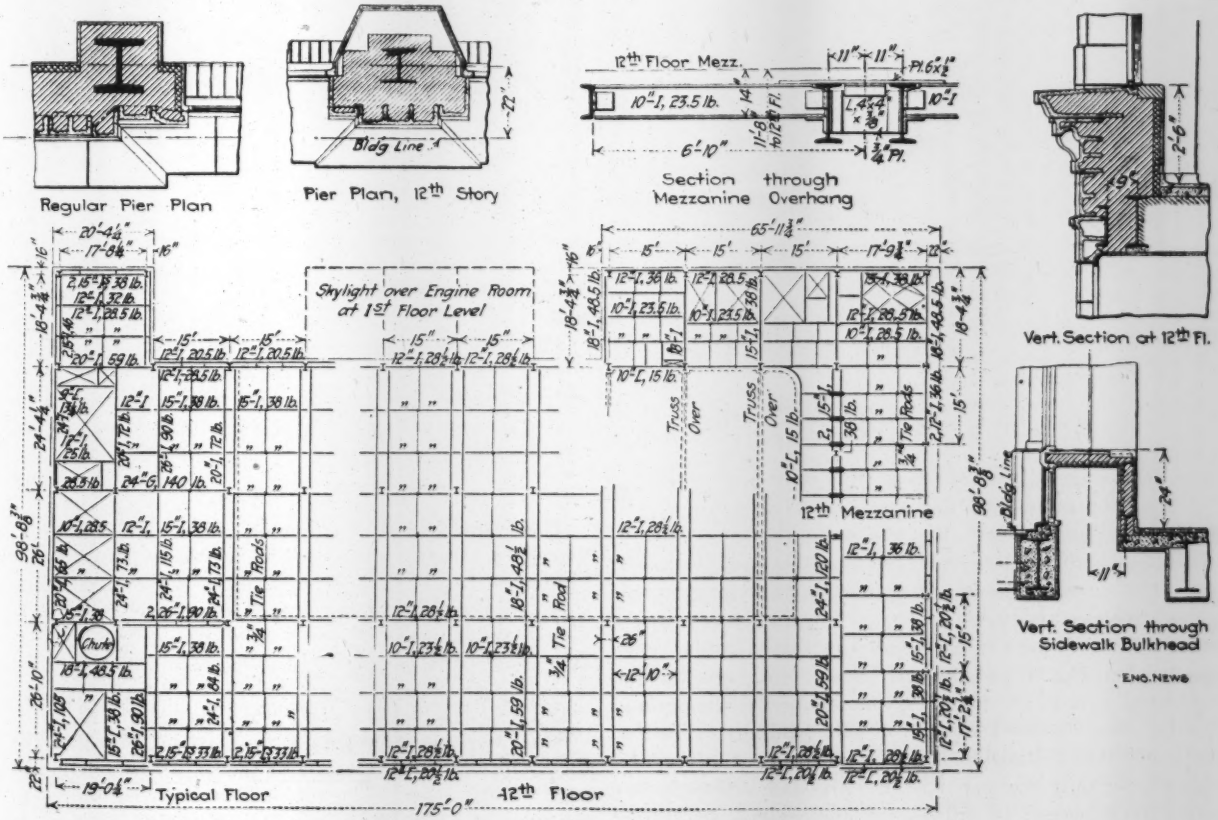


Fig. 5. Floor Framing of the Hill Building

the heaviest section rolled, the 14-in. H weighing 287½ lb. per lin.ft., was reinforced with flange and web plates to more than three times its sectional area. The maximum column has 265-sq.in. section.

The floor framing presents an unusual arrangement. The main girders, running transverse to the building, are double, straddling the columns. While this arrangement was adopted chiefly with a view to getting good details for the construction of the transverse bents, it proved an advantage in laying out the beam framing. The beams are 15-in. I's, spaced about 8 ft. on centers, taking a 16-in. flat-arch terra cotta floor; the strength of both arch

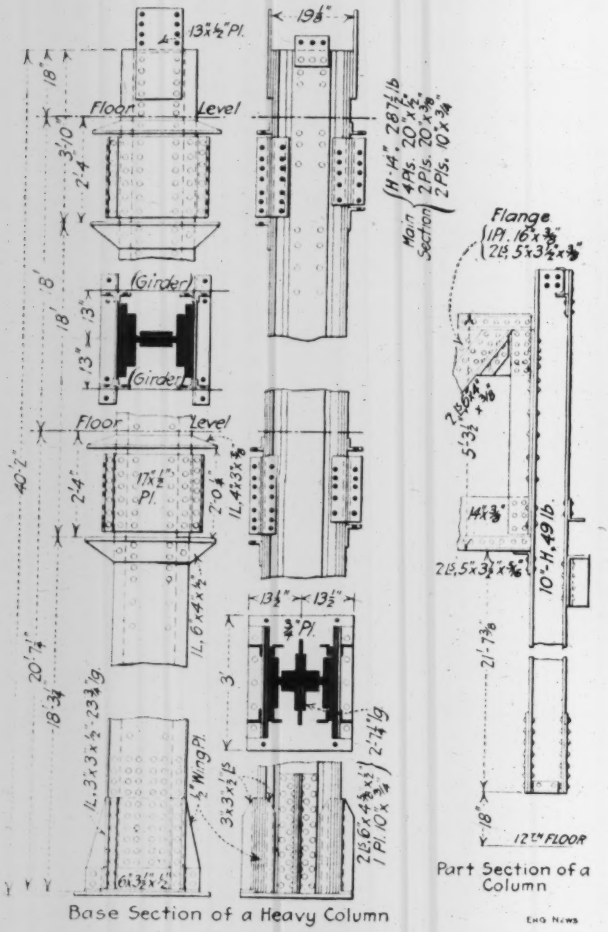


FIG 6. TWO REPRESENTATIVE COLUMN DETAILS

and beams is fully utilized on this span and spacing, while at the same time the terra cotta (extending 2 in. below the beam flange for fireproofing) comes up to within 1 in. of the top flange, so that the 5-in. thickness of surfacing concrete is left a practically uninterrupted sheet over tile and steel.

The floor framing is represented typically by the composite plan, Fig. 5, and the vertical sections, Fig. 3. The left-hand part of the plan, Fig. 5, represents a manufacturing floor designed for the 300-lb. loading, while the 12th and 13th mezzanine, being intended for office use, are figured for only 90 lb. per sq.ft. live-load, although the same arrangement of framing is maintained as in the heavier floors.

PROVISION FOR RIGIDITY

Printing-press buildings are notoriously weak in the matter of vibration resulting from the reciprocating movements of heavy masses in flat-bed presses. The presses used by the Hill Publishing Co. are rotaries, but as the tenants of the building would probably employ flat-bed presses the problem of suppressing vibration was considered of primary importance.

Great reliance was placed on the massive character of the structure as a steadier and stiffener. For rigidity of the transverse bents, effort was centered not on making the steel connections particularly stiff (as by brackets or by pure shear connections), but upon obtaining a securely connected composite structure through the use of concrete incasement of the columns and flaring concrete column caps merging into substantial concrete girders—the filling between the pairs of steel girders.

With the same purpose in mind of suppressing vibration and stiffening the whole construction, a rich stone

FIG 7. VIEW IN WEB-PRESS DEPARTMENT OF HILL PUBLISHING CO., 10TH FLOOR

(Permanent lighting fixtures not in place. Full indirect lighting has been installed.)

concrete was employed for the incasement of columns, filling of girders and floor surfacing layer. No cinder concrete was used anywhere except in shaping up the roof.

The unequal length of bay transverse to the building, already referred to, was intended as a protection against vertical tremor rather than against lateral sway. The fact is worth recording that during the past four months' service the building has proved remarkably rigid.

FLOOR CONSTRUCTION

The 16-in. National Fireproofing tile arch used in the floors is a novelty. The capacity of the arch is probably limited by the tie-rods rather than by the strength of the tile. In this case tie-rods were put in according to the requirements of the New York Building Code. Each floor-beam panel has one ¾-in. tie-rod not upset.

ARCHITECTURAL CONSTRUCTION AND FINISH

The large glass surface, which virtually characterizes the building, can be seen in the general view on the first page of this issue. The problem of securing proper appearance of a building in which flat wall surfaces are reduced to a mere skeleton is not easy, but the architects

believe that in this case they hit upon a pleasing solution. Unfortunately, the picture does not do the fact justice, as it cannot reproduce the appearance of the cream-colored mat-glazed terra cotta upon which the effect of the exterior really depends. The entire surface of both street fronts is of this material.

The edge faces of this terra cotta were ground, with a view to giving neat and close joints (see Fig. 8). The cost of this terra cotta face (in place) may be put at about twice the cost of face brickwork and about one-half the cost of stone facing. The court wall shows Kittaning face brick, with terra-cotta lintels. The rear wall is of common brick laid with a panel bordering of terra cotta.

Every block of terra cotta is anchored with a $\frac{3}{8}$x1$\frac{1}{2}$-in. galvanized ashlar anchor. At cornices and other special points, special anchoring is used. The balustrade which caps the wall is also of terra cotta, and here vertical tie-rods through each baluster with a continuous channel under the cap rail form the connection.

The roof is covered with Ludowici roofing brick laid in portland cement over "Barrett Specification" tarred-felt roof. Bent copper expansion-joint strips are laid in the brick at 50-ft. intervals in both directions.

Floors—As already mentioned, the floors have a 5-in. layer of concrete over the tile arches. This is stone concrete instead of cinder concrete, for strength and stiffness. It was believed that a very extensive load distribution would be secured through so thick and strong a surfacing layer; concentrated loads and impact from machinery being rendered harmless.

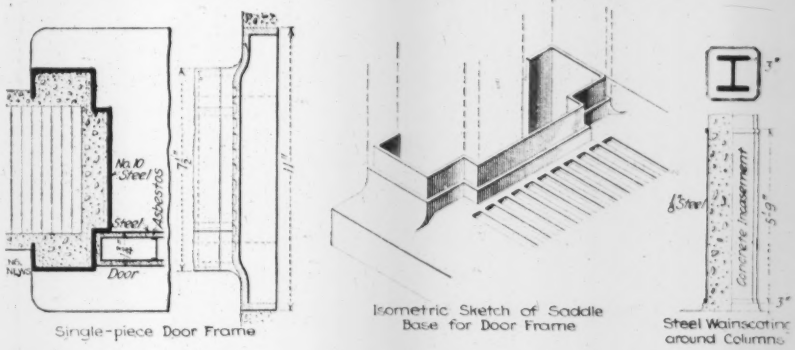


Fig. 9. Door Frame and Sill Details, and Steel Wainscoting of Columns

The upper 1 in. of this 5-in. coat is Master Builders' floor surfacing, chosen for its waterproof and wear-resisting qualities. This is used on all the manufacturing floors, but is omitted on the office floors (12th and mezzanine), where ordinary concrete floor finish was used; this floor is completely covered with interlocking rubber tiling, and the concrete is thus not exposed to wear.

Reference has already been made to the column incasement. This is 1:2:4 stone concrete in a square pier with chamfered edges, which gives a minimum thickness of 3 in. over the extreme points of the steel. The lower 5-ft. height of each column is surrounded by a steel wainscot jacket of $\frac{11}{64}$-in. plate with reinforcing bands at top and bottom. This wainscot was cast in, being set around the steel column and the concrete molded in it.

Sanitary Cove—As a novel feature of the floor construction, the concrete is carried up around walls and columns to form a lip or edge 3 in. high with cove of 2-in. radius. This simple expedient greatly reduces the amount of dust accumulation occurring in corners and angles in normal service. All door frames and column wainscoting are seated on this concrete lip. The door saddles are detailed to merge into the cove and form the actual support for the door frame and casing (see isometric sketch in Fig. 9).

In the 12th and 12th mezzanine stories the column casings are surrounded by furred false incasement for architectural effect; the interior finish here is wholly of Caën stone imitation. The spaces back of the furring are utilized for carrying up the radiator risers and the air ducts.

Ceilings and walls are finished in hard plaster. In the manufacturing stories the exterior walls are furred with 2-in. hollow terra cotta for plastering.

Stair and elevator partitions are 6-in. hollow terra cotta, without steel studding. Even door bucks are dispensed with; the formed steel door-frame is set direct in the partition masonry.

The main vent shaft shows ingenious design. It is divided into a supply and an exhaust shaft. Since the aggregate area of the two should be the same for all floors, the supply decreasing from basement up and the exhaust increasing, a sloping partition might have been used to

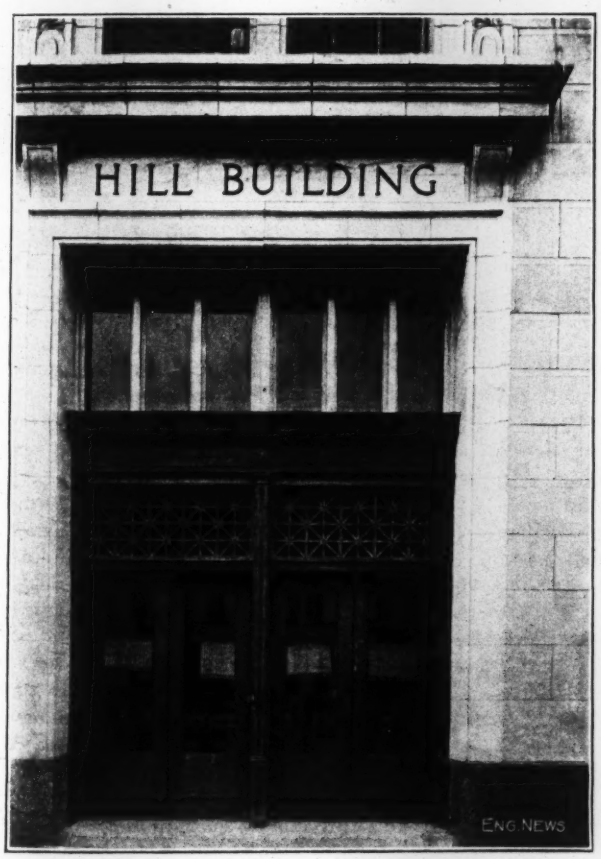


Fig. 8. Entrance Detail, Showing Good Effect of Glazed Terra Cotta with Ground Joints

divide the shaft. This, however, would have made the two sections present varying front widths along the east wall of the shaft, where the ducts lead off (Fig. 10). A helical or conveyor-blade partition was therefore designed, which divides the front wall into two equal parts at all floors, but swings around from the left side to the right side of the shaft on the way up through the 12 stories. The partition is formed of plaster on mesh attached to small furring angles connected to a vertical front angle and a helical rear-wall angle.

Windows

The building is equipped throughout with steel sash, selected with special view to two things: Minimum steel

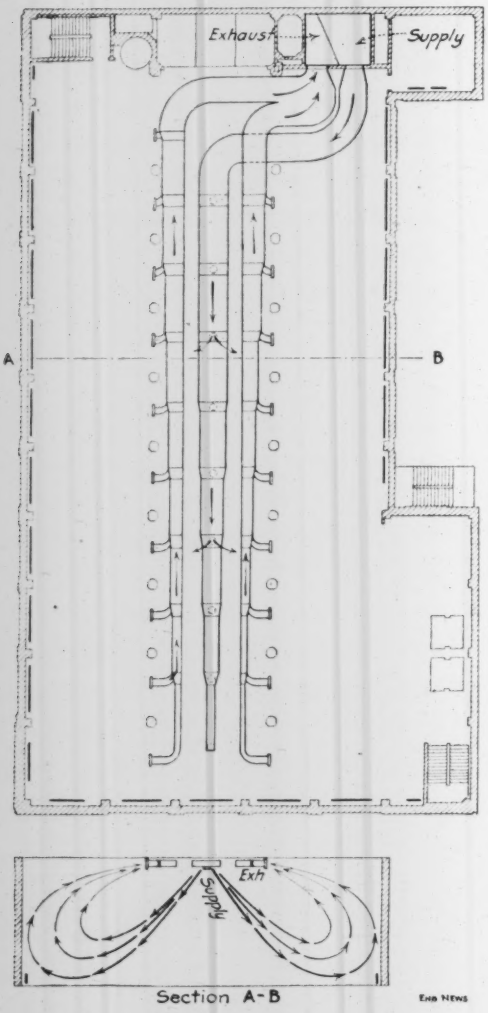


Fig. 10. Ventilation Duct Plan

area in a given window area, i.e., maximum glass ratio; and weathertightness. A careful study of all steel sash on the market was made by owner and architect, with the result of rejecting all commercial patterns and makes and having sash of special quality built by the Trussed Concrete Steel Co. These sash were fully described in Engineering News, Apr. 16, 1914, p. 844. They are glazed with ¼-in. plate glass. The advantages of light and cleanness secured by these windows and by their permanent closed position is enhanced by building the inside sill, adjoining the cast-iron sill rail of the window, of white enameled tile with rounded inner edge.

Steel Doors and Integral Trim

All doors and door frames throughout the building are of formed sheet-steel. The doors themselves are not paneled or molded but are perfectly plain. The frames represent a novel departure from prior practice. Instead of making frame and casings three separate pieces, the whole was formed of a single width of steel sheet. Thus, a door frame comprises only three pieces of metal, the rails and the lintel, which miter at the corners and are joined by angles.

The door itself is made of 0.05-in. steel sheet over a core of cellular steel construction covered with 4-in. asbestos board. Between the core cells are channel-shaped ribs, to which the outer shell is spot-welded.

All doors are hung on concealed hinges, or upper and lower trunnions, Rixson type. With few exceptions the doors are self-closing, the lower trunnion being a combined spring and check box set into the cast-iron sill.

Heating and Ventilation

It was natural that the equipment of the entire building should be particularly adapted for printing and publishing. Printing requires uniform humidity and temperature for best results. Therefore, in the Hill Building the windows are locked shut and conditioned air is supplied, up to some 8000 cu.ft. per min. per floor.

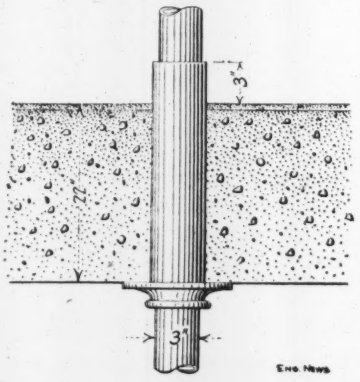


Fig. 11. Sketch of Riser Pipe Dam to Prevent Water Damage

The supply is drawn in from the street at the second-story level, passed through coarse wire screens, over heating coils, through perforated plates into a spray chamber, past drying baffles and heating coils, and finally through the fans which send it up the main vent flue and out through the distributing ducts on each floor. On days of high humidity the air is not washed, but cheesecloth screens set across the intake duct do the cleaning.

In the basement fan room are three complete Carrier conditioning plants (one spare), each with a 50-hp.-driven-motor Sturtevant multivane fan, capable of delivering 47,000 cu.ft. per min. When the outside temperature falls to 40° F., the wash water is heated with exhaust steam automatically introduced.

Exhaust ducts in each story take the spent air to the exhaust section of the vent shaft. Over this, in a roof penthouse, are two 77-hp. Sirocco fans discharging through ventilator hoods. In addition, two 7½-hp. fans, above the roof, draw air from the two series of toilet rooms and plumbing fixtures throughout the building.

The air supply is kept a few degrees below room temperature so that it will flow downward from the duct openings and assist proper circulation. The main heat

supply is from radiators hung on the walls of each story under the windows and supplied with hot water. The temperature of this is regulated from the engine room according only to the outside temperature (being varied between 195° in 5° weather and 100° for 65° outside).

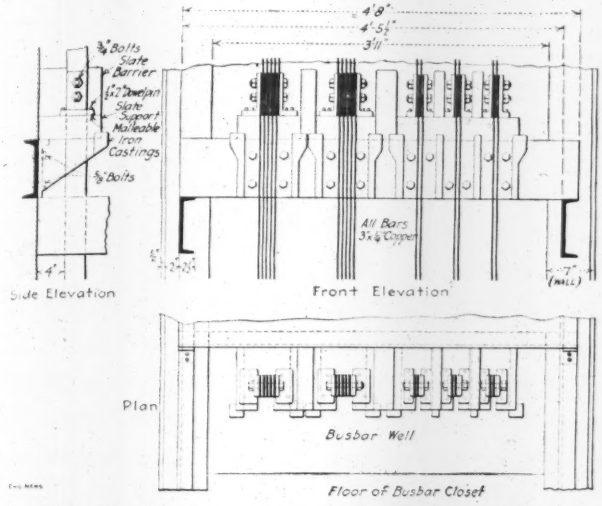


FIG. 12. VERTICAL BUSBARS IN INCLOSED WELL

(At each floor a panel-board is mounted in front of the well. Switchboard and well are inclosed in a closet.)

The circulating system has two Alberger closed heaters, using exhaust steam, and a 35-hp. motor-driven centrifugal pump with a De Laval turbine driving a pump of the same type and capacity as a spare unit.

The heating and ventilation facilities are sketched in Fig. 10 for one of the printing floors. The arrangement is modified for the twelfth floor and the ducts are concealed by the ceiling (Fig. 13).

WATER-SUPPLY AND FIRE PROTECTION

Water is pumped from two street services to a 10,000-gal. square steel tank in a house above the roof. This supplies the toilets, slop sinks, hot- and cooled-water circuits, etc., and the power plant. A 5x8-in. motor-driven triplex pump is ordinarily used, with a 10x6-in. steam duplex as a spare unit (both McGowan designs). Hot water for the slop sinks and wash sinks comes from a gravity circulating system using exhaust steam in a closed heater.

Drinking water is taken from the house line, filtered, cooled and circulated around the building, there being two bubbler fountains on each floor. For cooling the water a 4-ton 10-hp. York ice machine is used and a 2-hp. motor-driven centrifugal pump circulates the supply.

For the sprinkler system, water is stored in four 9000-gal. cylindrical closed tanks under the house tank. To secure adequate pressure on the upper floors of the building these tanks carry 80 lb. air pressure (obtained from a Westinghouse locomotive-type direct-acting double-compound steam-driven compressor which also supplies the air-washer sprays and the pneumatic carriers). One main sprinkler riser drops down through the building with branches for each floor. Should any valve be closed or any sprinkler head let go, alarm circuits are closed to advise an insurance supervisory bureau. In case of such warning, a runner is dispatched to advise of the trouble and see that it is remedied. The sprinkler mains also have a siamese street connection for fire engines. Each floor has two hose racks with connections to the house

FIG. 13. INDIRECT LIGHTING AND ORNAMENTAL OUTLETS OF CONCEALED VENT DUCTS IN OFFICE OF HILL PUBLISHING CO.

(12th floor, Hill Building)

supply. A new Gamewell fire-alarm system, with pull boxes and bells on all floors, connects directly with the city fire department.

To prevent damage from water dripping through the floors, scuppers with flap covers are provided to drain the floors into the court. The heating risers which pass from story to story are carried through the floors in pipe sleeves (Fig. 11), which rise above the finished surface some 4 in. to serve as a dam for accumulated water.

Lighting and Power Service

Each manufacturing floor has some 60 ceiling outlets for lighting, besides 42 floor and 22 pilaster and column outlets for power. Such of these floors as are used by the Hill Company have upward-reflecting ceiling fixtures, each with a 400-cp. nitrogen-filled incandescent lamp. These allow about 2 cp. per sq.ft. of floor area, which is supplemented by a few individual lamps for the under parts of presses and some proofreader's desks.

From the high ceiling of the twelfth floor, there are hung 14 indirect fixtures, each reflecting the light of four 225-cp. tungsten lamps. This allows about 2 cp. per sq.ft. of floor. Above and below the mezzanine are two similar fixtures per bay, each containing three 50-cp. lamps, giving $\frac{3}{4}$ cp. per sq.ft. of floor; but about the same resultant illumination is secured as out from under the mezzanine.

Vertical Busbars

Current for the several floors is supplied from the power-plant switchboard through five vertical busbars, three for the three-wire 240-volt lighting circuits and two for 240-volt power. Each lighting bus comprises two $\frac{1}{4}$x3-in. copper bars and each power bus has five such bars.

The busbars are bare and in lengths reaching from floor to floor. They rise through a special well and at each joint are bolted together and to a malleable-iron saddle which rests on a slate insulating block supported by brackets bolted to the floor-beams.

Power Plant

The varied services outlined above, and the power demands of the various tenants, require an electric power plant of 1350 hp. There are three engine-generator units on the basement level and three Heine boilers in a sub-basement. There are all the usual isolated plant auxiliaries except condensers, which are not installed because of the uses for exhaust steam, the fluctuating loads and cost of cooling water.

The engines are of the Lentz four-valve poppet-valve type, built by the Erie City Iron Works, chosen because of using 100° superheat with 150-lb. steam pressure. The 5-ft. height under the engine-room floor, around the engine foundations, serves as a pipe gallery.

The boilers have superheaters, balanced draft and underfeed stokers. The stokers (Taylor type) have a clinker crusher in the rear and this drops ashes and crushed clinker into a trench, about $2\frac{3}{4}$x$3\frac{1}{2}$ ft., running under the boilers. Two openings from this at each boiler pass the ashes to a vacuum pipe of a suction conveyor which delivers to a 10-ton storage tank on the second floor; this dumps directly into carts in the freight driveway.

The coal-handling facilities show a noteworthy departure, for deep boiler rooms, in the elimination of hand labor. Coal is dumped through sidewalk scuttles into a 500-ton sloping-bottom storage bin from which it runs through four gates 4 ft. above the floor. A 1000-lb. bucket receives it and is hoisted by an electric traveling crane (designed by the Northern Engineering Co., with a scale in the track) and carried to the stoker hoppers.

The entire plant is thoroughly provided with recording, as well as indicating, meters and gages (Venturi for steam, a Cochrane metering feed-water heater, outside and inside thermometers, circulating-system thermometers, voltmeters, ammeters and wattmeters for power and lighting, air and steam-pressure gages, etc.), assembled so far as practical, so that there is complete supervision of operation and check on efficient performance.

Conveying Facilities

The equipment for the necessary movement of persons, freight, mail, printers' copy and proofs, waste, etc., comprises power elevators, gravity chutes and pneumatic carriers, the first two serving all floors and the last only the editorial and printing departments of the Hill company.

There are two 43-hp. Otis electric passenger elevators carrying some 40 persons each (or 4500 lb.) and developing a possible speed of 600 ft. per min. The three 50-hp. freight elevators have a 7x10-ft. floor and a lift of 8000 lb.; they open into the 20-ft. interior freight driveway, so that vehicles can discharge and load at the elevator doors.

A 7-ft. spiral steel chute, with three separate slides, serves all floors for the descent of outgoing printed matter, mail, etc. One slide delivers over the sidewalk and two beside the freight elevators. There is a simple vertical steel chute for dropping waste paper into the baling room on the ground floor.

Starrett & Van Vleck, of New York, were the architects of the Hill Building, and also carried on the construction as superintendents. John A. Hill, President of the Hill Publishing Co., was active in all stages of the design and construction.

Fumes from Gasoline Locomotives in Tunnels and Mines—The use of gasoline locomotives is very rapidly increasing for mine haulage and for handling material in tunnel driving. At the Pittsburgh meeting of the Institute of Mining Engineers in October, 1914, Prof. O. P. Hood, of the U. S. Bureau of Mines, described the elaborate tests which had been carried on by the Bureau to determine to what extent the fumes from such locomotives are injurious to health. The experiments showed that the danger to the health of locomotive runners from the gases discharged by the locomotives was due not to the carbonic acid gas produced but to the carbon monoxide produced as a result of incomplete combustion in the cylinder. The tests showed that with carburetors set to give an excess of gasoline to the engine, an amount of carbon monoxide equivalent to 5¾% of the displacement may be generated. Running the engine at slow speed, throttled down very closely, also produces a high percentage of carbon dioxide. The total quantity delivered is less because of the slow speed of the engine. It appears that the chief danger in handling such locomotives in confined spaces is where the engine is allowed to run while the locomotive is standing and in a place where no ventilation current is passing. Under these conditions the air around the locomotive may soon become highly charged with carbon monoxide. It is an advantage, therefore, to equip such a locomotive with a self-starter so that it will not be necessary to keep the engine running while the locomotive is waiting for cars. Prof. Hood's experiments further indicated that to keep the percentage of carbon monoxide below the point at which injured health might result, current delivering not less than 1000 cu.ft. of air should pass the locomotive for each cubic foot of carbon monoxide generated.

Reconstruction of the Beds of the Cincinnati Water-Filtration Plant

The beds of the rapid sand filters of the water-works Cincinnati, Ohio, are being reconstructed. The brass wire-cloth screen between the sand and gravel layers is being removed, and the depth of the gravel layer increased to 14 in. in place of the 8 in. of gravel formerly used. The sand layer will remain 30 in. in depth, as heretofore. This will decrease the distance between the level of the sand and the top of the wash-water troughs about 6 in. Thus far, two of the 28 beds have been reconstructed and one is now under reconstruction. Eventually, all of the beds will be changed.

On account of the breaking of the brass wire screen and the consequent trouble encountered with the mixing of the sand and gravel, it is deemed advisable to remove the screen entirely, as experiments made at the plant had shown that this was feasible when the gravel layer is properly graded. In some places the screen was found to be torn away from its original fastenings because of their faulty character, while in others the wires of the cloth were broken. Unequal distribution of the wash water resulted in such cases, and although no bad effects have been traced to the breaks, so far as shown by the bacterial results, it has been thought best to make these changes before serious disturbances which might affect the purity of the water could take place.

The brass wire-cloth was constructed with No. 20 wire and had 10 meshes per lin.in., or 100 per sq.in. It has been in use for seven years, although evidences of its deterioration were noticed within three years from the time the plant began to be operated. The destruction of the wire cloth appears to be due to the small quantity of carbonic acid which remains in the filtered water after undergoing treatment. Corrosion of the wire of the cloth is plainly evident, and is progressing rapidly in places. The slight movement of the wire cloth due to the washing process is another factor in hastening the rupture of the wires. They become brittle under this movement, which, coupled with the lessening diameter of the wires on account of corrosion, causes them to break easily.

The original cost of the brass wire-cloth alone for the 28 filter beds, each of which has an area of 1400 sq.ft., was $10,688. To replace the screen and to provide better methods of fastening it would have probably cost between $20,000 and $25,000, including labor and material. Reconstruction of the beds without the screen and with deeper, larger and heavier gravel, will probably cost about $8500, including the rehandling of the sand, the screening of the gravel, and the necessary repair work upon the strainer plates. The latter require some cleaning out of the perforations ($\frac{3}{32}$-in.), and in some places a renewal of broken hook bolts is necessary.

The sand in each bed is being lifted by a portable hydraulic sand ejector and transferred to a bed, the bottom or gravel layer of which has already been reconstructed. The transfer of the sand by the ejector from one bed to another will effect a certain amount of cleansing of the sand.

The new gravel costs $1.39 per ton delivered at the filtration plant. This is equivalent to approximately $2.08 per cu.yd., and will amount to about $1500 for the new gravel for the 28 beds. Separating, grading, and placing the gravel, together with the necessary repair work and transferring the sand, will bring the total cost of reconstructing the beds up to the figure previously mentioned.

J. W. Ellms is Superintendent of the Filtration Plant and J. A. Hiller is General Superintendent of the Cincinnati Water-Works.

The Cobwell Garbage-Reduction Process

A single-unit garbage-reduction process which extracts the grease and converts the remaining solids into animal food, all in one small tank, has been under experimental and practical test for about a year past. The system is all the more noteworthy because the small size of a unit makes it possible to treat the garbage of even a small city by reduction, a thing heretofore thought to be impracticable. The new system has been in use at New Bedford, Mass., for six months, and is being installed at Los Angeles, Calif., and at the Panama-Pacific Exposition at San Francisco.

In this new system the garbage is treated in airtight units (steel tanks) of about three tons capacity. Here it is heated with a solvent for 6 to 10 hr. at a temperature sufficiently low to retain all the food values. Grease is drawn off continuously until practically all of it is removed. The tankage is then taken from the digestor, screened, and, so far as is necessary, crushed to the form of a meal, ready for stock food. Garbage meal made by this process is said to contain 20% of protein and animal meal (from dead animals) 65%. It is also said that from one ton of garbage about 500 lb. of solids and 100 lb. of grease are recovered, only some 2% of grease being left.

The process was first tested experimentally at the works of the C. O. Bartlett & Snow Co., Cleveland, Ohio, under the personal direction of Mr. Bartlett. For the past six months a unit has been in regular use as a part of the reduction plant of the New Bedford Extractor Co., of New Bedford, Mass., under the direction of M. J. Springborn, who, as Director of Public Service of Cleveland, was responsible for the municipal garbage-reduction plant of that city. In two or three months the whole of the New Bedford reduction plant will be changed over to the new system.

A practical test of the use of the stock food for hogs and chickens has been made by Mr. Bartlett at his farm, with satisfactory results.

At Los Angeles a 100-ton plant is being installed by the C. O. Bartlett & Snow Co., to carry out the contract awarded by the city in 1913 to C. D. Crouch. Under this contract (see ENGINEERING NEWS, Aug. 28 and Nov. 27, 1913), the city is to be paid 51c. per ton for all garbage delivered by it to the plant. It is expected that the Los Angeles plant will be completed in about four months.

The Panama-Pacific Exposition plant will consist of two units. It will be in operation about the middle of February, 1914.

The name Cobwell, which has been given to this new system of garbage reduction, is made up from the initials of Mr. Bartlett and from the name of the chemist, Mr. Wells, who has carried through the chemical end of the work.

New York Rapid Transit Railway Extensions*

By F. Lavis†

XI.—The River Tunnels

The Harlem River Tunnels

The general design of these tunnels is shown in the cross-section, Fig. 76. It was determined by two principal factors: First, the necessity on account of the conditions under which the approaches were located of keeping the tunnels as near the surface as possible; second, the desirability of obtaining a minimum total width to avoid encroachments on valuable private property.

The methods developed in the construction of the tunnels under the Harlem River for the original subway (see Engineering News, Oct. 13, 1904) and at Detroit‡ for the tunnels of the Michigan Central Ry., had shown the practicability of sinking tubes from the surface, and these methods also permitted much closer spacing than would have been possible with shield-driven tunnels, which latter would necessarily or at least most conveniently have had to be circular, with a reasonable space, say 10 ft. or so between each tube. It may be noted, however, that the tunnels which had been previously built by sinking from the surface were for two tracks only, whereas, the new Harlem River tunnel is for four.

Bids were originally called for late in 1910 on two types, H and K. Type H was similar to that of the original Harlem River tubes, and type K similar to the Detroit River tubes.

The bid prices were as follows, per lin.ft. of four-track tube:

Type K—Lowest $1925, highest $3000, per lin.ft. of four-track tube.
Type H—Lowest $2200, highest $3000, per lin.ft. of four-track tube.

Before the contracts were awarded it was decided to change the dimensions; the bids were therefore rejected and the work readvertised, this time calling for bids on three types, H, K and L. Types H and K remained the same except for the changes in dimensions. Type L was a modification of Type H, having the four tubes all together instead of in two pairs.

The bids on the latter two types were all rejected and that of Messrs. Arthur McMullen and Olaf Hoff, the lowest bidders on type K, was accepted; the range of bids at this last letting for the tube-tunnel section having been as follows, per lin.ft. of four-track tube:

Type K, $1500 to $1800, 8 bids.
Type H, $1650 to $2000, 3 bids.
Type L, $1550 to $2000, 6 bids.

The contract price of $1500, equal to $375 per lin.ft. of track, may be compared with the cost of the Detroit River Tunnels, which has been given as $332.29, exclusive of contractors' profits. However, the inside diameter of the Detroit tunnels was 20 ft., as compared with 16 ft. 6 in. for the Harlem River tubes.

The method adopted by the contractors with very few modifications was that developed for the construction of the Detroit River Tunnels, which has been quite fully described‡ in various papers and articles in the technical press. The article in Engineering News, of Feb. 15, 1906, is interesting as showing the development of the process. It consists essentially in the erection of the steel tubes in suitable lengths on shore, bulkheading the ends to get flotation, launching these sections, towing them to the site which has previously been dredged to the required depth, and sinking them in place by filling them with water (see photographs in Fig. 75). The concrete is then deposited around the outside by means of tremies, the sections unwatered and the inner concrete lining placed. This method, of course, obviates the necessity of general work in compressed air, though divers are used to a limited extent.

The accompanying drawings and photographs show the essential details of the structure and the methods of sinking and as the general methods have already been so fully described, it seems only necessary to call attention to such changes and improvements as experience and the particular conditions of the Harlem River work have shown to be desirable. The tunnel was divided into five sections, four of 220 ft. each and one of 200 ft.

In the Detroit River tubes, the circular stiffening angles, which are spaced about 8 ft. apart, were placed on the inside, as then it was thought necessary to provide temporary interior bracing in the form of the spokes of a wheel. Experience showed, however, that this might be dispensed with, and on the Harlem River tubes the stiffening angles were placed on the outside. This permitted the construction of the braces or struts to the wooden bulkheads or forms at the sides, which materially decreased the necessary thickness of the timber, which latter, in the case of the Detroit tunnels, was 6 in. thick at the bottom and 4 in. thick at the top. For the Harlem River Tunnels, 4-in. plank was used for the lower half and 3-in. for the upper.

The manner of making a tight joint between each of the sections shows an important modification in the direction of simplicity. The old joint with the pilot pin is shown in the drawing, Fig. 77a. This joint was not altogether satisfactory, as it was somewhat difficult to fit and the rubber gaskets are, of course, perishable. The new joint (see Fig. 77b) is a butt joint instead of an overlapping or sleeve joint, and the bolts on the outside are easily placed by divers. The inner plate, which, of course, is riveted in place after the tubes are unwatered, assures practical water-tightness. It will be remembered that the concrete is placed outside this joint before the tubes are unwatered, and tests made with the concrete deposited by the tremies at Detroit showed it to be of very good quality, sufficiently impervious to prevent any leakage of moment. The space between the joint in the shell and the inner plate is to be filled with grout after the latter is riveted in place. There is a pilot pin on each of the two outer tubes, and when both are home, the accuracy of the construction insures a good fit everywhere. The unwatering of the tunnels has shown these joints to be remarkably tight.

*Copyright, 1914, by F. Lavis.
†Consulting Engineer, 50 Church St., New York City.
‡Eng. News, Feb. 15, 1906, and Mar. 17, 1910. Proc. Inst. C. E., Vol. CLXXXV, 1910-1911. Trans. Am. Soc. C. E., Vol. LXXIV, 1911.

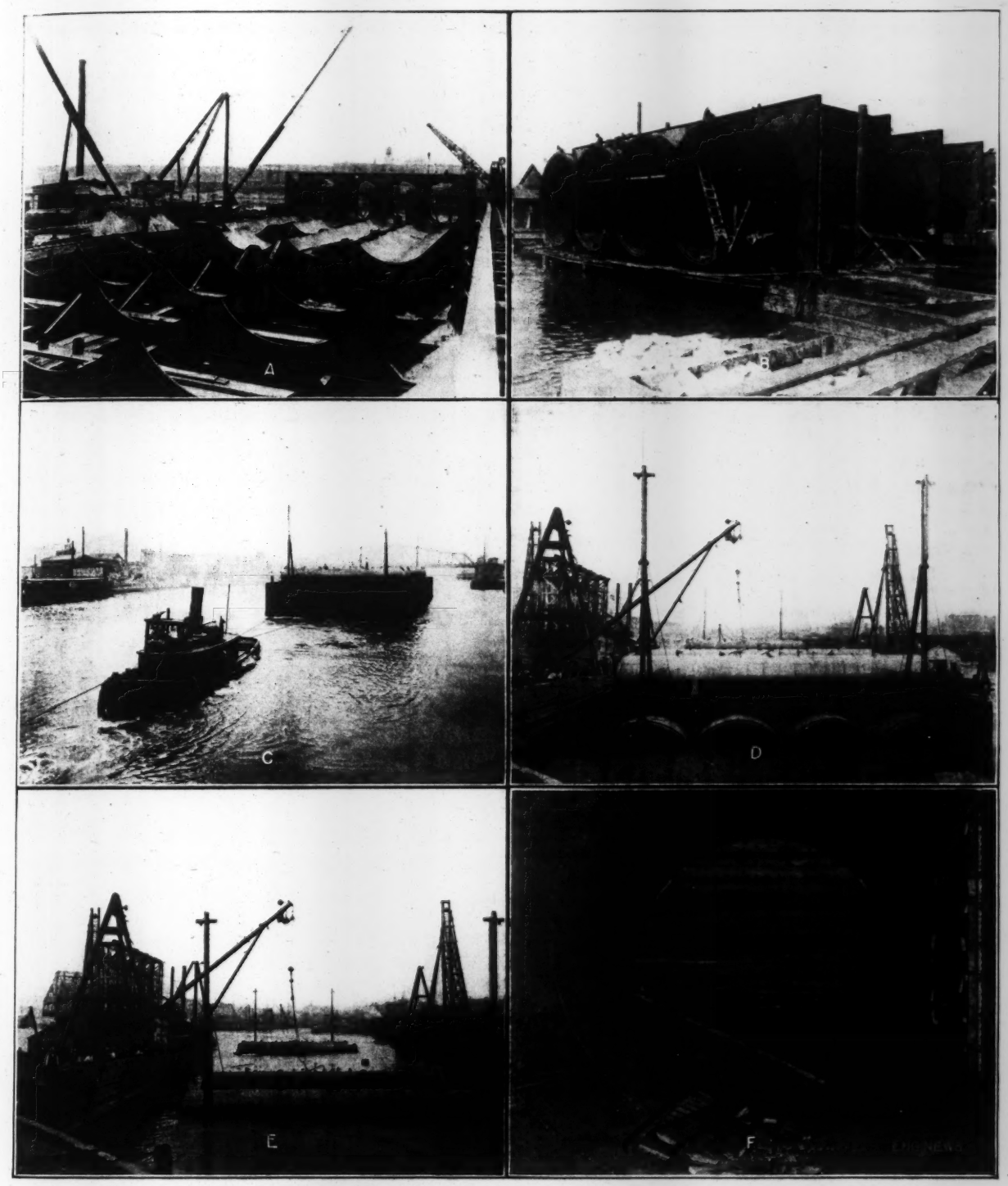
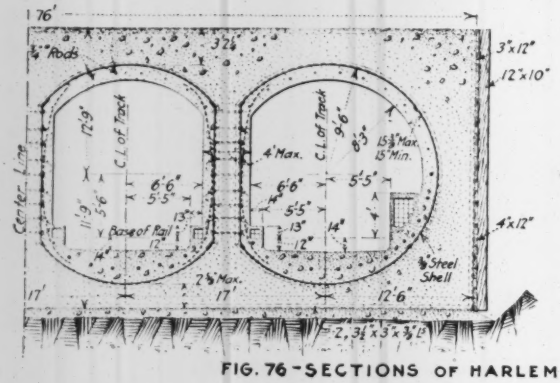


FIG. 75. VIEWS OF THE HARLEM RIVER TUBES DURING CONSTRUCTION
A—Construction, partial. B—Construction, completed. C—Towing to site. D and E—Sinking. F—Inside.

Attention may be called to the method of tying the tubes and the partition walls together, as shown in detail, Fig. 76. Reinforcement of 1-in. square rods is placed in the inner concrete lining. Longitudinal rods are spaced 12 in. apart at the sides. It is probable that this might be omitted and still leave the tunnels entirely safe, but is an added precaution thought advisable in view of the comparative novelty of the method.

Before launching a section, the two outer tubes were tightly bulkheaded at both ends, but the inner tubes only about 4 ft. up, as shown in the sketch, Fig. 78, that is, just high enough to provide flotation while being towed to the site. The outer ends of the *end* sections are, of course, tightly bulkheaded on all four tubes with bulkheads to stand total pressure for the depth, so they will hold when the tubes are unwatered. Photograph 75D shows the south-



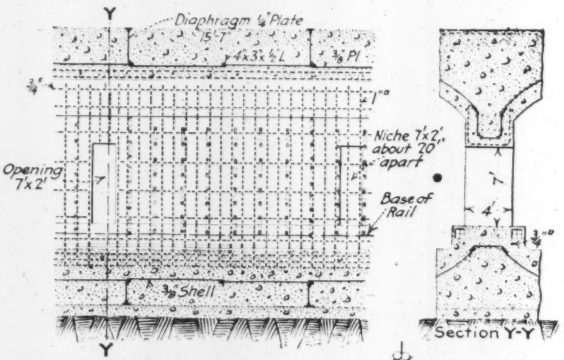
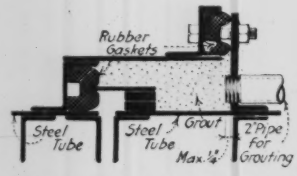


FIG. 76 - SECTIONS OF HARLEM RIVER TUNNEL



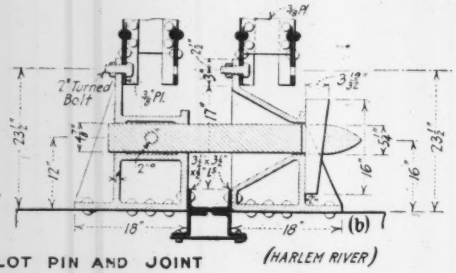
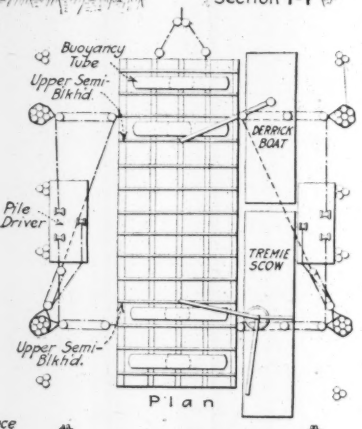


FIG. 77 - DETAILS OF PILOT PIN AND JOINT



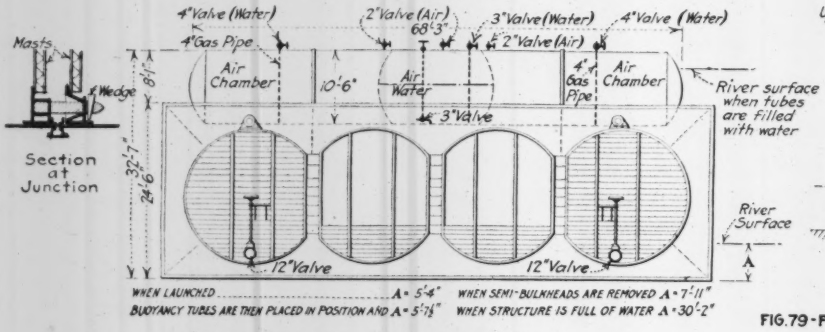


FIG. 78 - DETAIL OF BULKHEADS

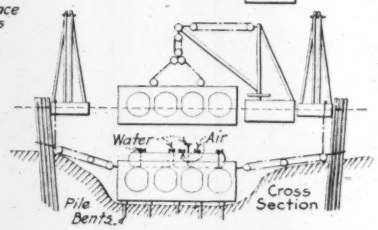
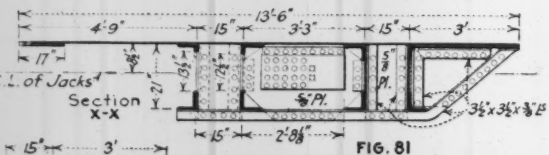


FIG. 79 - FLOATING EQUIPMENT FOR SINKING TUBES

HARLEM RIVER TUNNEL



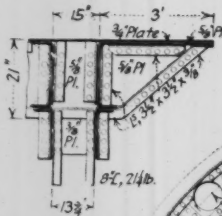


FIG. 81
DETAILS OF DOUBLE ROOF SHIELD TO BE USED FOR TUNNEL UNDER N.Y.C. & H.R.R. JUST NORTH OF THE HARLEM RIVER

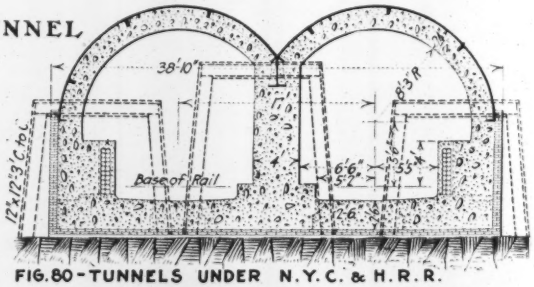
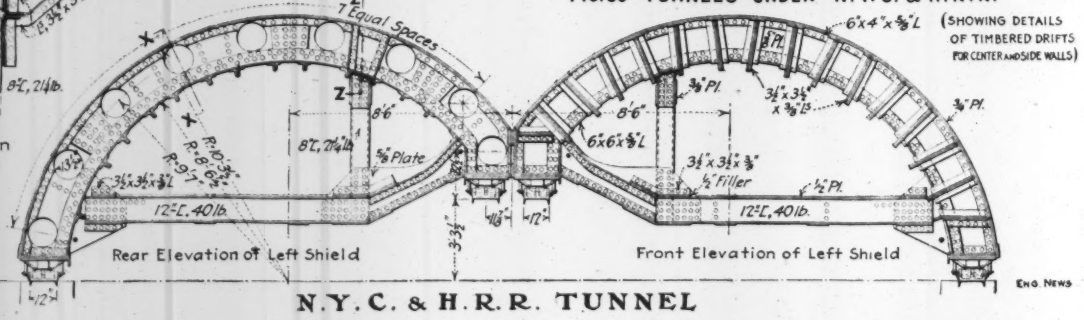


FIG. 80 - TUNNELS UNDER N.Y.C. & H.R.R.



(SHOWING DETAILS OF TIMBERED DRIFTS FOR CENTER AND SIDE WALLS)

N.Y.C. & H.R.R. TUNNEL

ery end of the first section *A* with all the bulkheads in. At Detroit the tubes were actually launched, by allowing them to slide down the ways as a ship is launched; on the Harlem River, however, it was thought best to build the structure on an open platform over the water, so that flat-decked lighters could be floated underneath to lift them off. The lighters used were water boats which could be filled by the opening of valves provided for the purpose and emptied by pumps. They were floated under at low water, raised by the tide to lift the tubes off the platform, and then when the tubes were moved over deep water were scuttled, leaving the tubes floating. On account of the narrowness of the Harlem River, there would have been some difficulties attending launching, but, in any event, the method used was thought to be better, and proved to be practical and very satisfactory.

The method of depositing the concrete around the outside of the tubes, and tests showing the good quality of concrete so deposited, were fully described in ENGINEERING NEWS, Mar. 17, 1910; the method and plant used on the Harlem River was almost exactly the same with one important improvement in the control of the tremies. The tremies are so arranged that they can be raised or lowered to accelerate or retard the flow of the concrete. At the head of each tremie and attached to it, is a platform on which stands the man who controls it. Individual hoists were provided for each tremie, controlled by a continuous rope passing by the platform, so that at any position of this latter the rope could be reached by the man, and the raising or lowering of each separate tremie made almost instantly and as required.

At the Detroit River a steel grillage embedded in concrete was placed in the bottom of the trench at the joints between each section, but at the Harlem River timber bents were driven. There were 4 to 6 bents at each joint; they were framed on shore and driven by two piledrivers, moored facing each other with long followers to reach to the necessary depth. On the first section the bents were driven an inch or two low so that the tubes might be blocked up; it was found, however, that such good control was possible that they were afterwards driven almost exactly to grade.

The method of sinking the tubes is very simple; 12-in. valves are opened in the bottom of the bulkheads in the two outside tubes, allowing these latter to fill gradually with water; the two inner tubes are entirely open. The rate of sinking after the tubes are half full is controlled by air valves at the top of the main tube, if necessary. There is apparently no difficulty in keeping them level, but to aid in this two cross bulkheads are provided, reaching half-way down from the top, providing three sections from which, after the tubes are half full, the air escapes and, consequently, the amount of water entering can be controlled by opening or closing the air valves. The tendency of either end or corner to get out of level was, therefore, easily controlled. As the tubes become completely filled, the flotation is carried by the four cylinders on top, which are in turn gradually partially filled and the excess weight, which is not great, is taken by derrick boats moored on either side during the sinking. The method of control of position is shown in the diagram, Fig. 79.

Some interesting statistics are as follows:

Weight of steel per lin.ft. of structure	5600 lb.
Amount of exterior concrete per lin.ft. of structure	30.0 cu.yd.
Amount of interior concrete per lin.ft. of structure	11.6 cu.yd.
Maximum depth M.H.W. to subgrade	57.2 ft.

The weight of the structure equipped for sinking, with masts, bulkheads, sheeting, buoyancy cylinders, etc., complete is 646 tons.

Buoyancy of four cylinders (on top)	722 tons
Excess buoyancy four cylinders	76 tons

requiring 19 tons of water in each to overcome buoyancy. One hour is required to fill the structure with water.

Cross passages are provided between the tubes at approximately every 50 ft., in the outer partitions, and two openings in the whole length of the tubes through the center partition. There is a sump in each tube at the lowest point, universal-joint cast-iron pipe being used for discharge. Access shafts—one for each tube—are provided near the ends of the end sections, by which access can be obtained to the interior of the tubes after the outside concreting is completed. The ends of the last sections are fitted with slots (two angles) to take the sheeting of the coffer-dams which are built to connect them with the land sections built in open cut. The connecting coffer-dam is of a single row of steel sheet piling; clay being dumped on the outside, if necessary, to make it tight.

Roof Shields

Just north of the Harlem River the westerly branch of the subway passes under the main line of the N. Y. C. & H. R. R.R., which at this point carries all the traffic from its own lines as well as from those of the N. Y., N. H. & H. R.R., to and from the Grand Central Terminal. The railway has five tracks and is carried on a fill between high masonry retaining-walls. The base of rail of the subway line is to be between 40 and 50 ft. below that of the railway above.

It was at first thought that this work might be carried out in open cut, carrying the railroad on timber falsework, but the acute angle of the crossing, depth and character of material would have made this a somewhat hazardous undertaking, and it was finally decided to adopt the method shown in the accompanying drawings.

Timbered drifts have been driven, as shown in Fig. 80, the center one, as will be noted, being considerably higher than the other two on the outsides. The material encountered has been mostly rock, but the work was rendered quite difficult in parts by reason of the fact that the top of the rock was just below the top of the drifts, requiring the support of the earth overhead and blasting of the rock below.

In these drifts the side and center walls are to be built of concrete and then the balance of the excavation is to be taken out under the protection of the double, segmental roof shields, details of which are shown in the drawings, Fig. 81. These shields, as will be seen, are quite unique in design and form. It is intended to work each independently of the other, shoving one at a time, but, of course, not to be the extent of one entirely clearing the other, as they necessarily react on each other to take up the side thrust.

The writer is especially indebted to Mr. Olaf Hoff, of the firm of McMullen & Hoff, the contractors for this work, for the above information, for the plans and details of these shields, and of the Harlem River tubes, he being principally responsible for the design and execution of this portion of the work.

The East River Tunnels

The additional connections between the new lines in Brooklyn and those in Manhattan are to be by means

of two pairs of tunnels under the lower end of the East River, as described in ENGINEERING NEWS, Apr. 30, 1914. The contracts for all four tunnels were recently awarded to the Flinn-O'Rourke Co. for a total amount of about $12,500,000, and work was actually started about Nov. 1 on the sinking of the shafts.

The tunnels are to be driven by the shield method and there are two novel features which are to be tried to which attention may be called at this time.

In several places the roofs of the tunnels are quite close to the river bed, so that additional cover must be provided. Owing to the swiftness of the tidal current at this point and its scouring action, the problem of retaining a clay blanket in place according to the method heretofore used in East River tunneling seemed to be one of some difficulty. The method proposed, however, will not only probably retain the clay, but by placing the material at this time (November, 1914) it will settle well into position and become nearly impervious, by the time the tunnels are driven. A comparatively narrow, thin blanket of clay is first deposited on a line on each side of the location of the tunnels. Rock from any of the numerous excavations always going on in and around New York is dumped on top of this and a clay blanket varying in thickness from 5 to 15 ft. is then dumped between these piles of rock, and is finally covered with other rock, as shown in the sketch Fig. 82. This blanket will be approximately 125 ft. in width over all. It is believed this clay blanket will stay in position and effect the desired purpose. The contractors have been fortunate in being able to obtain an excellent grade of clay from dredging in progress on the Hudson River, near Edgewater, N. J., which ordinarily would have to be towed to sea for disposal.

The second feature is a method of filling the annular space around the outside of the tunnel left behind the tail of the shield, when the latter is shoved ahead. The outside diameter of shields used for tunneling is usually from 6 to 8 in. greater than the outside diameter of the tunnel, this leaving a space of 3 or 4 in. all around to be filled by the movement of the surrounding material or in some other manner, as the shield is forced forward. This movement, while not always of importance, does tend to pro-

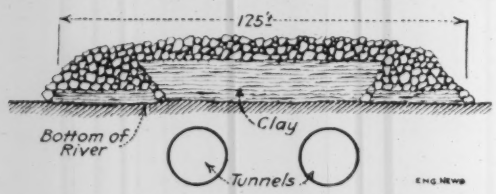


FIG. 82. METHOD OF COVERING RIVER BOTTOM OVER EAST RIVER TUNNELS

duce distortion to the cast-iron lining and to settlement of the ground above the tunnel, which latter may be undesirable by reason of possible damage to overhead structures, as in the street approaches to these East River tunnels, and as happened in Joralemon St., Brooklyn, during the construction of the Battery tunnel for the first subway line to Brooklyn. In such material as that under the East River, which is mostly sand and gravel, and especially with the tunnels so near the surface, any disturbance of the ground above the tunnels, even in the river with no buildings above, is undesirable. Its prevention will probably also tend to lessen the waste from escaping air.

The shield is to be built with a double skin of ½-in. plates separated by a space of 1¼ in. The clearance between the shield and the tunnel is ¾ in. The two skins are separated by 1¼x3½-in. separators. Eight rectangular pipes ⅞x1⅛ in. inside, ⅜ in. thick, project through the back of the shield, and gravel similar to that used for roofing purposes, is blown through these pipes by air pressure to fill the space as the shield is shoved ahead.

Experiments on a small scale have already been made which show fairly conclusively the feasibility and practicability of this method for preventing any movement of the surrounding material into the space left by the shield, but a full-size shield is now nearing completion with which final tests are to be made with the complete apparatus.

If the two improvements above described succeed in any marked degree in overcoming the difficulties usually experienced in tunneling through water-bearing loose sand and gravel, with light cover, by reason of blowouts, the generally quite considerable loss of air, consequent heating of the tunnel, and the settlement of the ground above, they must be considered as a distinct advance in the art of subaqueous tunneling.

The writer is indebted to John F. O'Rourke and W. Gray, who have developed these methods, for the above information.

Some Results of Experience with Piles and Pile Tests

The following interesting statement is made by J. W. Taussig, on the part of the Raymond Concrete Pile Co. It is elicited by our request for information on pile tests and the conclusions derived from the results of that test:

In the last fifteen years the Raymond company has made upward of 200 tests on piles of all kinds, driven under every condition. Wood, precast, and various kinds of molded-in-the-ground piles have been loaded, and close observations made as to their behavior. Without drawing any comparisons, the following facts have been learned which are applicable to all pile tests:

1. *Age of Pile*—The bearing power of a pile increases greatly with the time the pile is in the ground. The increase is very rapid immediately after the pile is driven and continues for an uncertain length of time. Our experience leads us to believe months elapse before the full strength of the pile is developed.

2. *Speed of Loading*—The test load a pile will carry more nearly approaches the ultimate value of the pile if the load is applied slowly. By ultimate value we mean the load under which the pile would fail after the structure it is designed to carry is in place. Usually ten tons per day is as great an increase in load as should be placed on the pile, but 15 or 20 tons may be put on if speed is imperative. Just what relation the ultimate load bears to the time allowed for testing we have been unable to determine.

3. *Vibration*—Vibration of the pile, due to exterior causes, will not appreciably reduce the test load carried, unless the soil is of quaky or very soft character. A pile in such material depends almost entirely on skin friction generated by the adhesion of the soil to the pile and not on the ordinary friction due to compression in the soil as well as to adhesion. The adhesion of the soil when acting without the assistance of compression is apt to be

destroyed by shocks so that failures may come suddenly under comparatively light load.

Comparison of Test Load and Bearing Power

Economic circumstances usually require the test to be made under the worst conditions for the pile. The sooner a pile can be tested, the quicker the work can proceed, which is always of great importance. The same desire for speed necessitates the loading of the pile in the least possible time, so that often 50 or 60 tons is placed in a single day. The test is often made while other piles are being driven in close proximity. This sets up the most violent vibrations in the test load.

Under actual conditions the load is put on the piles very slowly. By the time the structure resting on the piles is completed, enough time has elapsed to allow the piles to reach their full or ultimate value. Even though the foundation may be subjected to vibrations after the structure is completed, the effect of these shocks is minimized as the entire structure is bonded together and the working load is usually only half to two-thirds as large as the test loading.

It is evident, therefore, that a pile giving satisfactory results under test will give a much better account of itself when subjected to its working load. Comparisons between the bearing power of piles must be drawn under as nearly similar conditions as possible. Wood and cast piles can be tested immediately after driving, so far as their own internal strength is concerned. It is, however, unwise to test these in less than two or three weeks, as this time is necessary to allow them to get a fair bearing value. Piles molded in the ground must not be tested until the concrete has attained sufficient strength to support the load. This usually requires about three weeks, although piles only two weeks old are often tested satisfactorily. Raymond piles have been tested in three weeks to a point where the concrete at the top was under a compression stress of over 1100 lb. per sq.in. This high loading is undoubtedly made possible by the support afforded the concrete by the spirally reinforced shells, which contain about 10 lb. of steel per lineal foot of pile.

Test Method

Tests are made in a number of ways. The load, consisting of a platform loaded with sand, water, iron, lead or other material, is usually balanced on a single pile, as the testing of more than one pile at a time requires handling an excessive amount of loading material and prohibitive expense in providing a suitable holder.

The value of results obtained from loading three or four piles at a time is incommensurate with the expense and difficulties attaching to the test, as experiments have shown the loads carried on a group of piles are closely proportional to the number of piles tested.

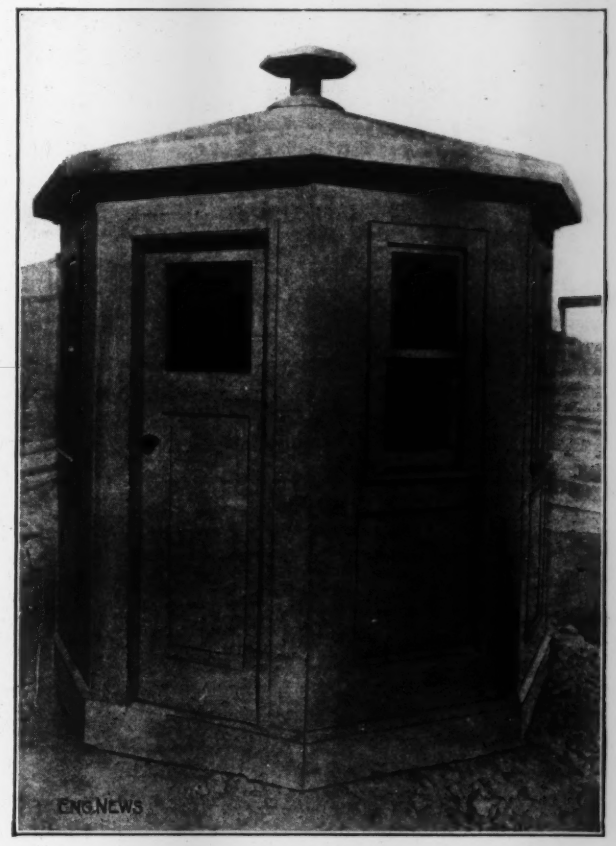
Cost of Tests

The expense of tests varies greatly, but usually approximates $2 a ton for load applied. This seemingly high cost is due to the expense of the testing platform and other special apparatus necessary. Careful and experienced supervision is of the highest importance, as not only must the test be conducted in a suitable manner, but the results obtained must be properly interpreted in order to draw the correct conclusions.

Portable Buildings of Monolithic Reinforced Concrete

The use of portable monolithic reinforced-concrete buildings for such railway structures as oil houses, switchmen's cabins, telephone booths, and waiting stations or shelters is increasing, and these buildings have advantages in cost, durability and appearance.

The smaller buildings are hexagonal or octagonal in plan, and range from 4 to 8 ft. diameter, with a minimum ceiling height of 7 ft. 4 in. The floor is about 4 in. above the bottom, in order to provide an air space beneath, and the sides (2½ to 4 in. thick) are paneled on the outside



A Portable Reinforced-Concrete Building
(A shelter station for an interurban railway, but suitable also for a watchman's cabin at a road crossing.)

for the double purpose of reducing the weight and improving the appearance. At the top is a 6-in. opening, with concrete ventilator. The weight of these structures is from 2 to 5 tons. The larger buildings are rectangular in plan, 8x10 ft., and weigh about 9 tons.

The reinforcement consists of electrically welded wire mesh and horizontal bars fastened to heavy vertical bars which are placed at the corners and extend to the middle of the roof. In the smaller buildings these rods are placed radially within the roof and are hooked to a circular rod around the ventilator opening.

These concrete buildings are manufactured by the C. F. Massey Co., of Chicago, Spokane and New York. The buildings are handled by cranes or derricks, the hoisting chain being dropped through the ventilator opening and fastened to a timber placed across the inside of the roof.

Beargrass Creek Storm-Water Channel at Louisville, Ky.

By J. H. Kimball*

SYNOPSIS—The Beargrass Creek was practically an open main sewer, with an irregular channel and numerous bridges, and its limited capacity (reduced by filling) led to serious flooding in times of freshets. It has been straightened, deepened and lined with concrete to form a storm-water channel, an intercepting sewer being built to carry the sewage. It is 40 to 70 ft. wide, with concrete retaining-walls 4 to 24 ft. high, the walls including gravity, cantilever and counterfort sections. The construction work was done by day labor.

The city of Louisville, Ky., is provided on its northern and western boundaries with a convenient means of disposal of its drainage by the Ohio River. In the eastern section, Beargrass Creek, the only open stream of material size within the city limits, has served as the natural outlet for drainage. Other smaller creeks have been replaced by trunk sewers, but this stream (draining a considerable territory both within and beyond the city limits) will remain as an open channel.

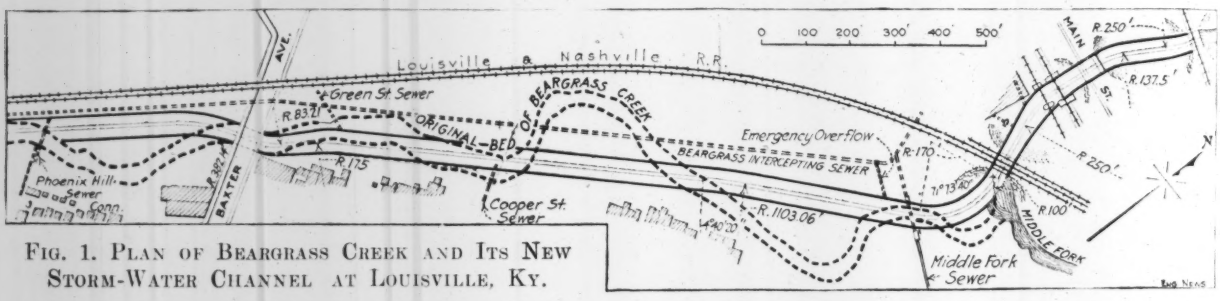


Fig. 1. Plan of Beargrass Creek and Its New Storm-Water Channel at Louisville, Ky.

Beargrass Creek drains a territory of 65.4 sq.mi. The soil throughout the basin is clayey, and the surface is undulating, with some small hills of steep slopes. The maximum difference in elevation is about 320 ft. and the average slope of the branches is from 4 to 5½ per 1000. Only a small proportion of the territory lies within the city limits and this is practically all improved as a closely inhabited residence territory. The area outside of the city is largely cultivated land.

The course of the stream was originally meandering (Fig. 1), and the bed lay in a valley often of considerable width. As the property became more valuable, the waterway was improved to a slight extent by an occasional straightening, but the principal change was that of filling and encroachment by which the course became much restricted. Bridges have been built, obstructing the flow to a greater or less extent, and trestles, which collected obstructions, rubbish and débris in large quantities, especially where the trestle bents were not parallel to the direction of the stream. In none of the bridges was the span equal to the proper channel width. At one of the truss bridges, the abutments and wing walls were so built as to interfere greatly with the flow, and other bridges were poorly designed with reference to location and direction of stream.

In addition to earth filling placed for the purpose of reclaiming land, there has been dumping of all kinds of refuse materials and dead animals. No abuse apparently was thought too great to heap on the stream. It was the natural outlet for drainage, and not only storm water but sewage was discharged into it through public and private sewers. Such treatment naturally caused a very offensive condition, particularly in warm and dry seasons. In periods of low precipitation, the flow of the creek within the city consisted almost wholly of sewage, and septic action was very noticeable in the numerous pools along its course.

In the preliminary plans of the Commissioners of Sewerage, an intercepting sewer was planned to take the sewage of the many public sewers discharging into the stream. This has been built, but in times of storm these sewers still overflow into the creek. Only such work as was necessary to drain the stagnant pools was planned to be done on the creek itself.

The improvements on the watershed naturally developed a greater concentration of flow, and the filling of land along the creek caused a loss in storage. With these conditions, and the encroachments and obstructions in the channel, freshets have occurred with increasing frequency. Not only was this an annoyance and injury to private owners, but during the most severe freshets streets and railway tracks were flooded, traffic stopped, and water forced back into the sewers.

During the early part of the work of the Commission it was decided to make an exhaustive study of the creek in order to design a comprehensive plan for its improvement. Fortunately, a very severe storm on Feb. 22-23, 1909, while the investigation was in progress, provided means of collecting data on flood conditions. From all data available, this freshet was the greatest ever occurring in the creek. The rainfall was 4.72 in., according to the recording gage at the office of the Commissioners, and 5 in. by the Weather Bureau gage. This was the heaviest fall on record at Louisville, with one exception.

This freshet was the cause of great damage. Streets were flooded, traffic on the Louisville & Nashville R.R. was stopped and the roadbed gullied, buildings were washed away, basements of dwellings and industrial establishments were flooded. One very important feature of

*Consulting Engineer, 414 Louisville Trust Building, Louisville, Ky.; formerly Designing Engineer for the Commissioners of Sewerage of Louisville.

the freshet was the effect on the storm flow from sewers discharging storm water into the creek. Two of the principal sewers of the city were entirely submerged and the water level in the creek rose to a height several feet above the top of the sewers and nearly equal to the elevation of the surface of the ground at many points in the system, and backing into cellars through private drain connections. The intimate relation between the condition of the creek and the efficiency of the sewers, as shown by this freshet, showed very forcibly the importance of an improved channel for the stream.

The investigation resulted in a report on a general scheme for straightening, deepening and widening the channel, and providing masonry walls and floor. The most serious problem was that of adjusting the location of the improved channel so as to conform to existing structures, extensive changes in which would necessitate too great an expense.

The problem of deepening was not particularly serious. At the junction of the South and Middle Forks, the bed was at a sufficiently low elevation, so that along the main stem between this junction and the Ohio River the problem was one of removing elevations in the bed to produce a uniform or at least a continuous grade. The bed of the South Fork was found to be 3 ft. above the invert of the largest sewer discharging into it, and also somewhat above the invert of another large sewer, these being the sewers mentioned as submerged in the great freshet. A further requirement, and the one which determined the grade of the South Fork, was the necessary elevation of an important relief sewer to be built in the future. The maximum depth below the old creek elevation required for these storm-water sewers was about 7 ft., excavation for which would be largely in rock.

The line of the creek was found to be largely controlled by the many railway and highway bridges. These influenced the stream in three ways: by acting as obstructions, by causing bends in the course of the stream, and by narrowing the channel. The chief offenders of the first class were the trestles, carrying spur tracks of the L. & N. R.R., and it was considered that these should be replaced by plate-girder bridges, but after conferences with the railway company, industrial tracks were built to parallel the creek on the opposite side from the main track, thus obviating the necessity of any spur-track bridges. The elimination of one of the plate-girder bridges was made possible by the closing of the street which passed over it. In the design of the improved channel, the waterway provided was to be clear without piers or other obstruction.

The location of the bridges was not, in the main, unfavorable to the course of the stream. In two cases, however, in which the main line of the railway crossed the channel on plate-girder bridges, it was found necessary to relocate these as skew bridges of longer span and on a different location. One of the largest and most expensive bridges, a stone arch carrying a street with very heavy traffic, was built at right angles to the street, although the general course of the stream was at a considerable angle with the street. On account of the expense of building a new bridge, the line of the creek was curved on either side of the bridge to conform to its location.

The most serious trouble to be found with the bridges was the insufficient width of waterway provided. Fortunately, it was possible to increase the grade of the creek through the localities where the bridges were most frequent, which made it possible to design a waterway which would be theoretically sufficient at nearly all points. The location of the improved channel is shown as Fig. 1.

The Improved Channel

The improved channel for Beargrass Creek was designed for a runoff of 185 cu.ft. per sec. per sq.mi., for the South Fork and 180 cu.ft. for the creek below the junction of the South and Middle Forks. An increased depth beyond the 9 ft. assumed in the design would increase the discharge to 200 cu.ft. per sec. per sq.mi. or more without damage to surrounding property.

The design provided for concrete-masonry walls and floor (Fig. 2) shows the typical section, southwest of Baxter Ave. For about 7500 ft. from the river, the channel was designed to have a width of 70 ft., with side walls 4 ft. above the floor and banks graded to a slope of 1 on 2. The floor is depressed at the center 3 in. below its elevation at the side walls, and has a small channel 11 ft. wide and 9 in. deep to carry the dry-weather flow. From the upper end of the 70-ft. channel to the junction of the South and Middle Forks (a distance of 580 ft., within which five bridges were to be passed), the grade was increased and the width reduced to 45 ft.

For the first 2500 ft. on the South Fork, there was room for any desired width of channel, and there was but one bridge. The width selected was 50 ft., narrowed at the bridge to conform to its width. For a distance of 4500 ft. above this section, the available room was very limited although a steeper grade was possible, so that the width was made only 40 ft. The walls varied in height from 4 to 24 ft., according to the elevation of the abutting land, the use to which it was put or its value, and the possibility of sloping the banks. The accompanying table shows the sizes of channel, velocity of flow, discharge, etc.

Distance, ft.	Channel width, ft.	Grade, per cent.	Velocity, ft. per sec.	Discharge, cu. ft. per sec.	Capacity, cu. ft. per sec. per sq. mi.	
7500	70	0.20	18.2	11,800	180	Main Stem
580	45	0.40	24.1	10,070	183	"
2575	50	0.80	10.95	5,070	184	South Fork
4270	40	0.14	13.9	5,150	187	" "

In all sizes, the depth of flow is taken at 9 ft., that being the elevation at which it was desired to limit the flow under all but extreme conditions. During the great floods in the Ohio River, back-water from the river will stand at an elevation much higher than this.

In explanation of the high velocities shown in the table, it may be stated that an examination of the inverts of old storm-water sewers in the city indicated that the material carried by them had but little effect on the masonry. The only case in which a measurable scour was found was in a sewer built over 50 yr. ago, in which the theoretical velocity was 26 ft. per sec., and the invert brick had lost but ¼ in. by erosion. In hardness tests made with a machine of the Dorry type, samples of concrete made with Ohio River gravel (1:2½:5) showed wearing properties superior to those of brick from the Louisville sewers. In fact, the concrete was found to compare very favorably with samples of street-paving brick.

This absence of wear in the old sewers may be due to the nature of the mineral matter carried in these sewers. The detritus from street wear in the macadam streets is composed principally of the fine limestone dust

resulting from the material of which the streets were built. The detritus from a macadam street built of a harder material would undoubtedly have caused a greater scour. The detritus from granite and vitrified-brick pavements is apparently too small in amount to cause appreciable wear on the sewers.

Some observations by the Reclamation Service ("Safe Velocities of Water on Concrete," ENGINEERING NEWS, Jan. 4, 1912) indicate that in the absence of gritty matter, concrete is able to withstand very high velocities of water. The watershed of Beargrass Creek having for nearly its whole area a clayey surface soil, the storm flow has a very high turbidity but the matter held in suspension is not of a gritty nature. In the future, when the creek is improved throughout its length in the city, and the upper areas are developed so as to increase the run-off and develop the theoretical velocities, the sloping earth banks above the tops of the low walls will need protection. For the present, high velocities will be diminished by the retardation of the flow due to the lack of improvement in the lower reaches of the creek.

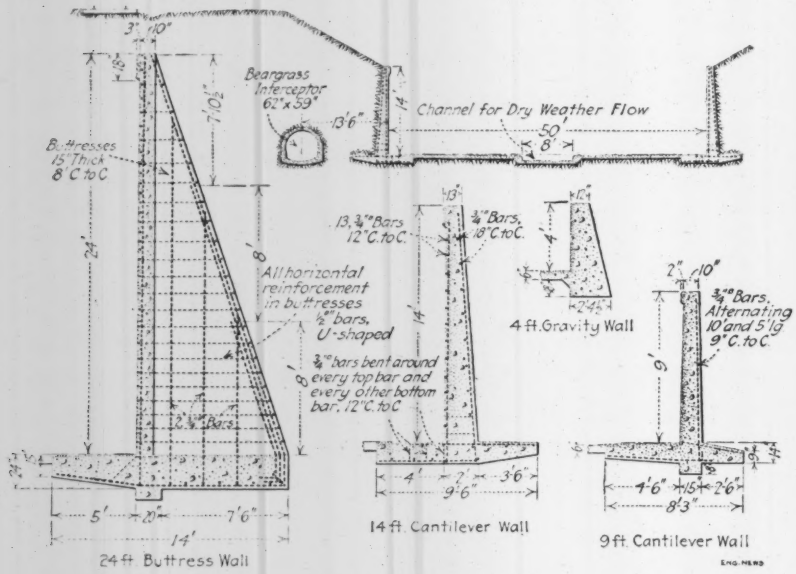

Beargrass Interceptor 62"x59"
Channel for Dry Weather Flow
50'
8'
Buttresses 15" Thick 8' C. to C.
24'
All horizontal reinforcement in buttresses
¾" Bars, U-shaped
¾" bars bent around every top bar and every other bottom bar, 12" C. to C.
13, ¾" Bars 12" C. to C.
¾" Bars, 18" C. to C.
4 ft. Gravity Wall
¾" Bars, Alternating 10" and 5 1/2" 9" C. to C.
24 ft. Buttress Wall
14 ft. Cantilever Wall
9 ft. Cantilever Wall

FIG. 2. CROSS-SECTION OF BEARGRASS CREEK CHANNEL, AND TYPICAL SECTIONS OF THE RETAINING WALLS

Although the line of the improved channel was made as direct as possible, changes in direction were necessary at the various bridges and also to a slight extent on account of topographical features. All changes in direction were made with curves and the channel lines were made tangent to the lines of the bridges (Fig. 1). The minimum radius used for the center line was about twice the width of the channel. This short radius was used in one instance only and then from necessity on account of existing structures. That this curve was sharper than desirable was shown by the fact that a deposit was formed on the inner side of the curved channel after a heavy freshet.

The studies on the best type of wall for the channel resulted in the selection of the gravity type for the 4-ft. walls, the reinforced-concrete cantilever type for walls 9 ft. to 14 ft. high, and the buttressed or counterfort type for the 24-ft. walls (Fig. 2). The changes in height from 4 ft. to 9 ft. were made with a sloping wall of the gravity type, and from 9 ft. to 24 ft. with a sloping wall

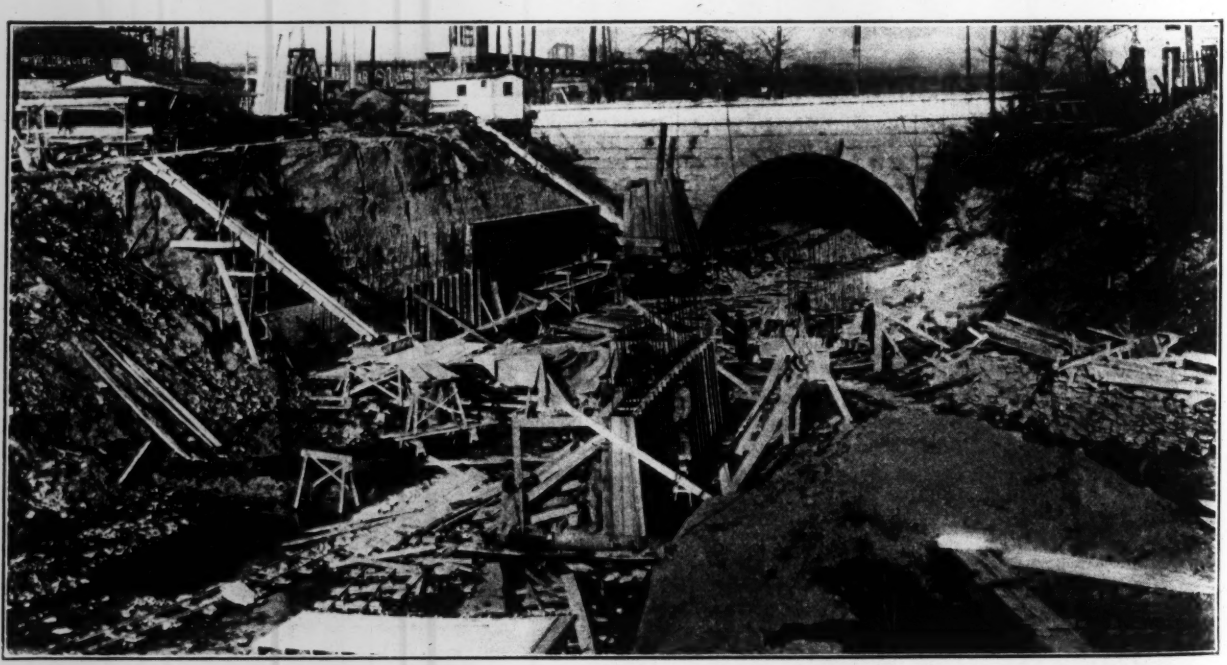


FIG. 3. CONSTRUCTION OF THE CONCRETE CHANNEL IN BEARGRASS CREEK, SOUTH OF BAXTER AVE. BRIDGE, LOUISVILLE, KY. (50 FT. WIDE, WALLS 14 FT. HIGH)

the cantilever type. As it was decided to construct the floor of masonry, it was thought wise to utilize the toe of the wall as a part of the floor. For this purpose, the toe was set farther to the front than is commonly done. This design lessened the amount of excavation and of concrete masonry. The floor was designed of masonry to obtain a smooth surface for the sake of capacity and to facilitate the cleaning of the bed of the creek when it should become necessary. The floor was designed

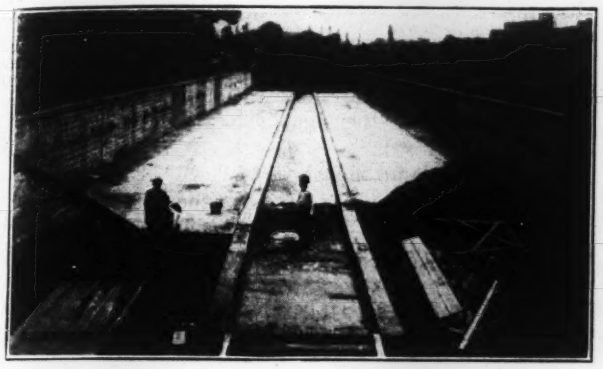


FIG. 4. A COMPLETED SECTION OF THE BEARGRASS CREEK CHANNEL (SOUTH OF JUNCTION WITH THE MIDDLE FORK)

with a thickness of 6 in., but during construction this thickness was reduced (where rock was encountered) to a minimum of 2 in.

The Commissioners of Sewerage were directed originally to construct a comprehensive system of sewers, and no more work was contemplated in the preliminary plans than a slight improvement in the grade and the removal of obstructions in the bed. As the importance of a substantial improvement became more apparent, the situation was studied to determine the value of a partial improvement. As a result, it was decided to construct about 2700 ft. of the channel complete with masonry walls and floor. About 400 ft. of this was built to facilitate the construction of a section of the intercepting sewer at the side of the creek.

Fig. 3 shows the work under construction just south of Baxter Ave., where the walls are 14 ft. high. In the center of the view is a length of the form for the wall, while at the left is a completed stretch of the opposite wall, with form being erected for another section. Fig. 4 shows a completed stretch of the improved channel, south of the junction of the Middle Fork. This shows clearly the arrangement of the floor slabs on either side of the central channel, with a chute for depositing concrete at the left. Fig. 5 shows an interesting view on the completed work.

CONSTRUCTION WORK

On account of the uncertainty of determining in advance the cost of the work, which was nearly all to be done in the existing bed and subject to serious delays and damage by flows in the creek of all degrees of intensity, and by floods in the Ohio River, it was decided to perform this construction by day-labor. A day-labor force had been organized under F. C. Williams, Resident Engineer, for certain sewer construction on which the contractors' bids were considered unduly high. This force had been very successful with the previous work and was well organized for the creek construction. Another advantage of the day-labor system was the ease with which the amount of work to be done could be adjusted to suit the amount of funds available. This was desirable as this work was postponed until near the end of the construction of sewers. The total expenditure for the creek was about $170,000, which was less than the receipts from interest gained through the good management by the Commission of the $4,000,000 bond issue. The expense of the investigation and construction together was met out of the surplus above the face value of the bond issue.

The construction work was facilitated by the use of the intercepting sewer built in the valley for the disposal of the flow of water in the creek in dry weather. By this means, all but a small amount of water was avoided, except at storms, in the majority of the work. At the junction of the South and Middle Forks, a sand-bag dam was used to divert the flow into the sewer. At two points where the new channel was built on a new location, and where the excavation was between 9 ft. and 24 ft. deep, the earth (20,000 cu.yd.) was removed by contract; in one instance, by wheel scrapers and in the other by steam-shovels and teams.

The work of construction as a whole was of such a nature that the use of extensive equipment was not warranted. A traveling derrick with buckets and small steel

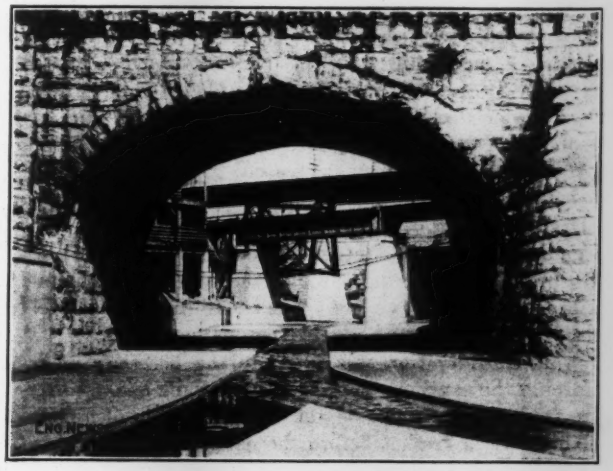


FIG. 5. THE BEARGRASS CREEK CHANNEL, LOUISVILLE, KY.

(Just below junction of the South and Middle Forks, with three railway bridges.)

dump-cars were used to move earth and rock excavation by the day-labor force, and these with a concrete mixer and a number of light drills operated by steam comprised the total equipment in addition to small tools. With the exceptions noted above, the excavation was, to a large extent, of slight depth and was moved with pick and shovel either with or without the use of the derrick. The excavated material was deposited back of the walls and used in raising the level of land in the immediate vicinity of the channel. In order to prevent the pressure on the walls from a heavy fill of mixed rock and earth, the rock was carefully deposited or piled so as to be self-supporting, so that it would relieve rather than add to the pressure on the walls.

Excavation beneath the bridges was necessarily car-

ried on with extreme care, particularly where rock was encountered. Below an old limestone bridge, the excavation of 4 ft. of rock was required. Blasting was done at the center with light charges of dynamite, and relieving holes were drilled as close as possible to the abutments, but no dynamite was used in holes less than 6 ft. from the abutments. The rock at the abutments was trimmed off with bull points. Although no signs of weakness were apparent in the arch, the excavation revealed a very poorly constructed foundation, the abutments resting on large stones deposited in the bed of the creek. The bridge masonry was carefully underpinned not only to prevent settlement in the structure but also to secure it against erosion. In another old limestone arch, immediately below the junction of the South and Middle Forks, the bed of the stream had been eroded nearly to the extent of endangering the bridge abutment. At this point, the bed required filling in order to raise it to the proper elevation for the masonry floor.

Expansion joints were designed to be placed at the planes between the toe of the wall and the floor, and between the floor and the center channel. Transverse expansion joints in the wall and floor were required at a maximum distance of 30 ft., but as built, an expansion joint was used at the end of each section, which, in the case of the lower walls, was 15 ft. The 24-ft. wall was built in independent sections 30 ft. long, with expansion joints at the ends. These joints in the walls were made of layers of tarred paper coated with pitch. The joints in the floor were generally made by pouring pitch into the space left by the removal of thin boards or shingles temporarily placed along the planes of the joints at the time of placing concrete. The expansion joints were varied in thickness, according to the season, those placed in winter being much thicker than those placed in summer.

Drainage of the material behind the wall was provided by a 4-in. pipe laid continuously back of the wall, with branches extending through the wall to the channel at intervals of 30 ft. or less. The backfilling immediately behind the wall was of selected porous material.

Some consideration was given to the necessity of reinforcing the cantilever and buttressed walls against pressure from the channel side, on the assumption of a channel filled by a freshet before the earth pressure back of the wall was developed. But as water in the channel would find its way to the back of the wall at an equal height either through the drainage pipes or (during construction) around the ends of the walls, this course was decided to be unnecessary.

Although the work of the Commission covered a length of only 2700 ft., it accomplished a marked reduction in the height of the flood waters. A storm of extreme severity occurred near the close of the work which demonstrated the value of the work done. Although it had a greater total precipitation and greater intensity than the storm of February, 1909, it caused little or no damage. In the earlier storm, the flood water reached a height of 18 in. over the street surface at Broadway (the next street above the creek improvement), while in the later storm the maximum height was 4 ft. below the street surface, showing a reduction in height of 5½ ft.

Since the completion of the work of the Commissioners of Sewerage, the improvement has been taken up and continued by the city through its Board of Public Works. This work, covering a length of nearly 5000 ft., has followed in general plan, the scheme of the Commission.

J. B. F. Breed was Chief Engineer, and Harrison P. Eddy, of Boston, Mass., was Consulting Engineer of the Commissioners of Sewerage.

Lamp Signals for Day Service on Electric Railways

An interesting development in the introduction of block-signal systems for interurban electric railways is the use of lamps for both day and night indications, thus dispensing with semaphores and their operating mechanism and simplifying the signal equipment very materially.

Two daylight lamp signals are shown in the accompanying cut; the one at the left is on the Indiana Union Traction line and the other is on the Terre Haute, Indianapolis & Eastern Traction line, both being of the "absolute-permissive" automatic block system of the General Railway Signal Co. There are three lights in each signal, the two upper lights constituting the main signal, while the bottom light is the permissive indication which practically subdivides the block for following movements and enables trains in the same direction to run at closer intervals than the distance between passing sidings (this distance being the length of the main block). The visibility of each light by day is increased by a hood projecting over the top and side of the lens, as shown.

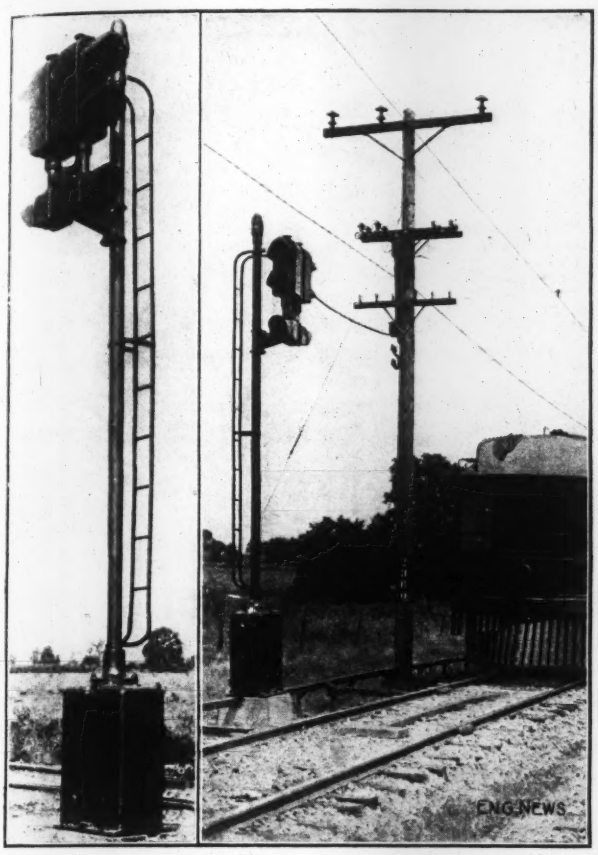
The development of this type of signal is reviewed in the report of the Joint Committee on Block Signaling, presented at the recent annual meeting of the American Electric Railway Association. A condensed abstract of this part of the report is given below.

The first installation of signals constructed on scientific principles for both day and night service was in 1907 on the Brooklyn Bridge, by the Union Switch & Signal Co. These signals had 5-in. lenses giving both green and red indications and were equipped with 10-in. hood but were not provided with any artificial background. Two 16-cp. lamps were mounted behind each lens. In 1911 short-range light signals for daylight conditions were installed in the Pennsylvania terminal in New York by the same company.

The use of light signals on high-speed interurban lines having continuous track circuit control is of recent origin, and the first trial was made on the Michigan United Rys. in February, 1911, by the General Railway Signal Co. This was a temporary signal, mounted in a wooden case and arranged so that either 8⅜-in. or 10½-in. red and green lenses could be used. The 115-volt, 80-watt tantalum lamps were mounted so that the center of the lamp filament was directly behind and coincided directly with the focus of the lens. Reflectors were used behind these lamps. Energy for the lights was taken from the 600-volt trolley and cut down to 115-volt by resistance. It was found that with the sun shining directly into the face of the signal, the red light could be seen about 1500 ft. and the green light about 1000 ft.

In 1912 the above company installed a light signal on the line of the Lehigh Valley Transit Co., near Center Valley, Penn. This was in connection with an installation of semaphore signals, for the purpose of comparing the suitability of the light signal for interurban service, but it was finally taken out and replaced by a semaphore in order to have all signals uniform.

Long-range signals of this type were installed by the Union Switch & Signal Co. on the Washington, Baltimore & Annapolis Electric Ry., in 1912. They were of the type installed in 1907 on the Brooklyn Bridge, except that the hood depth was increased to 34 in. and a shield extending 12 in. on each side was added to form an artificial background. Each signal had two lenses, one red and one green, and behind each were mounted two 110-volt, 25-watt, 16-cp. tungsten lamps wired in multiple. No reflectors were employed, so that indications could not be affected by headlights. The use of deeper hoods, artificial background and the white light



LIGHTS AS BLOCK SIGNALS FOR DAYLIGHT INDICATIONS

(The lights are hooded to increase their visibility and to screen the lenses from direct rays of sunlight [and headlight]. The signal at the left is one on the Indiana Union Traction System, and that at the right is on the Terre Haute, Indianapolis & Eastern Electric Ry.)

of the tungsten lamps so improved this signal as to provide suitable indication at 1600 to 1800 ft. under the most severe daylight conditions.

The first complete signaling installation with light signals throughout was on the Brazil Division of the Terre Haute, Indianapolis & Eastern Traction Co.,* and was completed and put in operation in the early part of August, 1912, by the General Railway Signal Co. An installation on the Indiana Union Traction System,* by the same company, consisting of 29 blocks of light signals which protect 50 miles of track, has (according to the company) proved entirely satisfactory, although at first the continuous track circuit gave trouble from dirty rails in paved streets. Since the cause has been recognized, this trouble has not interfered with operation.

These signals have 40-watt lamps, and 8-in. lenses with hoods, and in daytime the signal indications can be read clearly at 3500 ft., and at night on the longest tangent, 2.05 miles. This installation has been in service since 1912 and so far there has been but one false clear indication given by the signals, and it is doubtful if this could be charged against the signals. No difficulty has been experienced in picking up signals, and phantom indications (due to arc headlight reflection) have not so far been given, nor has the continuity of operation been affected by heavy sleet storms experienced in the winter of 1913. So far as operation and cost of installation are concerned, the light signal is the equal of the semaphore. No complaints have been received from the trainmen with regard to these signals.

The Illinois Traction System, although having the majority of its signals of the semaphore type, has some light signals and believes that the light signal is of advantage because it can be read a greater number of hours during the average day of operation.

The one all-important feature of light signals is the correct reading of the indication, and while in most cases the lenses are hooded to shade the rays of the sun and headlights, it is said that with an 8-in. lens a layman can read the indications at 2000 ft. and a motorman at 2500 ft. Recent tests at New Haven have shown that with existing types of light signals using 15-watt lamps, indications were distinctly visible 1500 ft. distant. These signals had 8-in. lenses, and it is said that if they had been equipped with 10-in. lenses, the indications in the daytime would have been visible at 3500 ft.

The committee submits what it considers to be good practice in regard to sizes of lenses for use with light signals: (A) For high-speed interurban service, a lens of not less than 8⅜-in. diameter should be used on all light signals operated by continuous track circuits. (B) For moderate-speed roads, a lens of not less than 5⅜-in. diameter should be used where light signals are operated by trolley contact or other end set devices.

*The signals of these two installations are shown in the accompanying cut.—Editor.

Large-Sized Stone for Bituminous Macadam in Ohio

A part of the $7,500,000 of contracts let by the Ohio State Highway Department in 1914 was for roadway having a top course of bituminous macadam, built by the penetration method. The broken limestone used for this top course was from 2½ to 4 in. in size. The general specifications under which this work was done, after stating how the stone should be spread and then rolled to a firm and even surface, continued as follows:

Where this top course is thicker than 3 in. after rolling, the bottom voids up to within 2½ in. of the surface shall be filled with coarse sand, or screenings, as the Commissioner may direct. Each shovelful of screenings shall be applied thinly over the surface and the rolling continued as the screenings are being applied.

After the top course has been rolled and completed as specified above, the voids in this course shall be partially filled with screenings, free from dust, that will pass through a ¾-in. and over a ¼-in. circular mesh, which shall be whipped into the surface from shovels. The surface shall then be gone over with a stiff fiber broom, and the loose screenings remaining on the top swept into the voids, or off the surface. When deemed necessary the rolling shall be continued during the application of the screenings. The filling of the voids in this top course shall be such that the amount of bituminous material specified shall fill the remaining voids just sufficiently to produce a dense surface when the road is completed. Any dust remaining on the surface shall be removed by sprinkling with water. Sufficient time for the stone to dry shall elapse before any bituminous material is applied.

The hot bituminous filling, either tar or asphaltic, was applied at the rate of 1¾ gal. per sq.yd. The surface was then dressed with "hard, clean screenings of stone, slag or gravel, ¾ to ¼ in. in size, and rolled until firm." Finally a seal coat of ½ gal. per sq.yd. of the same bituminous material, heated, was applied, more screenings added, the roller used, and then a final dressing of screenings was applied "to protect the surface of the road while setting up."

James R. Marker is State Highway Commissioner of Ohio, and C. E. Schoenmaker is Deputy Commissioner for Construction.

Steel Railway Ties are likely to be largely substituted for wooden ties on Indian railways, according to the government report on Indian Railways just issued. Both steel and cast-iron pot sleepers have been used in India for many years with a fair degree of success, but have hitherto been found expensive in comparison with wooden ties. The diminishing supply of timber with the steady increase in price has changed conditions, and it is stated that the use of metal ties will probably be greatly extended in the next few years. The government is also experimenting with various processes of treating timber ties to increase their life and preserve them from the attacks of white ants, and has asked for bids for the supply of wooden ties so treated.

Vitrified-Brick Pavement on an Old Macadam Base, Carlisle, Penn.

By John C. Hiteshew*

During the past season 2493 sq.yd. of vitrified-brick pavement were laid by the Street Department of Carlisle, Penn., under the supervision of the writer.

Track Section—The section paved comprised one block on High St., the main business street, through which the tracks of the Cumberland Valley R.R. run. The railroad company was unwilling to pave between and along the tracks, but it agreed to construct a concrete curb, 6x18 in., set 2 ft. from outside face of curb to rail. The concrete was a 1:2:3 mix with a 1:1 finish coat, and was constructed by contract at a price of 35c. per lin.ft.

Pavement Base—The old macadam with which the street was paved was used as a base for the new brick paving. The macadam had a depth, before excavation, of at least 18 to 20 in.

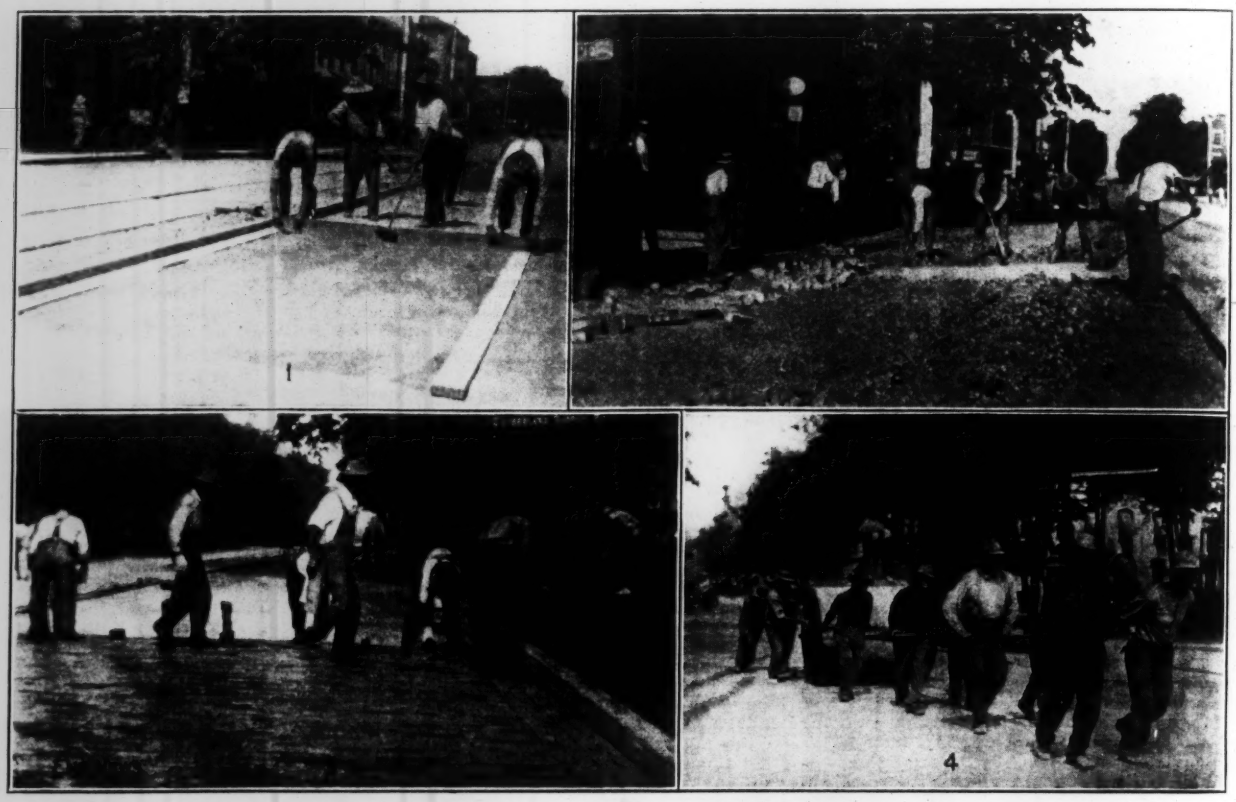
In grading, the old macadam was spiked up with a 13-ton steam roller, excavated to subgrade, and thoroughly dry rolled, as with wet rolling the macadam showed a tendency to push ahead of the roller, causing waves.

In shaping the base spikes were set to subgrade at 7-ft. intervals across the street, and the final shaping done by hand picking. After rolling, new spikes were set, which supported the 3x8-in. by 16-ft. guides for a striking template.

Concreting Filled-in Trenches—The Gas & Water Co. had recently renewed a great many trenches along the street, and poor foundations existed in the old gutters, so it was deemed advisable to fill all these new trenches and the gutters with concrete 5 in. deep.

Stone Cushion—The cushion was composed of limestone dust and screenings, 1½ in. in thickness; and was struck off by means of a short striking template drawn by three men, as illustrated in Fig. 1. The cushion was then rolled with a 250-lb. roller drawn by hand.

Laying Bricks—The bricks were laid by one foreman and two men, one of the men breaking half-brick to fill in ends of courses. Usually there were three men carrying to each brick layer. An average of 7000 bricks were laid by each man per day. Vitrified-shale paving blocks were used.



Figs. 1-4. Constructing a Vitrified-Brick Pavement on an Old Macadam Base
(1) Grading old macadam. (2) Striking template for sand cushion. (3) Laying brick. (4) Rolling.

Rolling Bricks—Rolling was done with a 5-ton horse roller drawn by 12 men.

Grouting—The joints were grouted with a 1:1½ portland-cement grout.

Expansion Joints—A ¾-in. "Elastite sandwich" joint was used longitudinally along the four curbs and transversely over 75 ft.*

"Elastite" was found to be a great improvement over the old pitch expansion-joint filler, doing away with the

*City Engineer, Carlisle, Penn.

*Transverse expansion joints are contrary to the specifications and recommendations of the National Paving Brick Manufacturers' Association.

boards, wedges, heating the pitch, etc., and the first cost of the joint was practically the entire cost, as it took very little time to place it in position.

SAND COVERING—The green pavement was covered with ½ in. of sand for several days. Traffic was turned on the pavement at the end of five days.

COST DATA—The following is an itemized list of cost data:

	Total	Cost per Sq.Yd. of Pavement
Unloading and hauling brick	$193.74	$0.0777
Grading and rolling subgrade	280.73	0.1126
Concreting trenches	211.36	0.0848
Crushed stone cushion	135.50	0.0543
Brick	2143.98	0.8600
Laying brick	93.85	0.0376
Rolling brick	15.64	0.0062
Grouting	210.72	0.0845
Expansion joints	88.75	0.0356
Covering with sand	11.74	0.0047
Total	$3386.01	$1.358

Dump wagons were charged at the rate of 10 and 15c. per hr. The reason for this was that they were fire teams; one

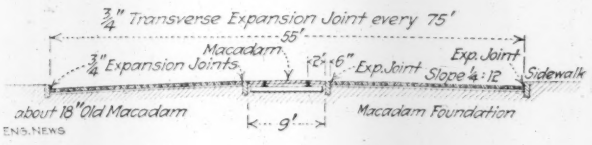


FIG. 5. CROSS-SECTION OF BRICK PAVING ON AN OLD MACADAM BASE, CARLISLE, PENN.

was paid 10c. per hr.; for the use of the other the Street Department paid the driver's salary, which was $1.50 per day, or 15c. per hr.

The bricks were purchased in March at a reduction of $1 per M. The great advantage in this was that we got a better run of bricks and had them when needed, and we saved $1 per M, or $100 on the year's work.

All macadam excavated was used in resurfacing streets adjacent to the work. Approximately 20,000 sq.yd. were thus resurfaced.

It will be noticed that a stone cushion was used instead of sand. The reason was that when first tried as an experiment the stone formed a compact cushion without becoming too solid, and at the same time reduced the cost by one-half.

A Dinner Party in a Boiler Furnace

The huge Stirling boilers installed in recent years at the Del Ray plant of the Detroit Edison Co. have attracted wide attention in the engineering profession, being by far the largest boiler units ever constructed and having attained a phenomenally high efficiency, together with a capacity to be operated at several times their normal rating.

A new boiler of this type has recently been installed at the Connors Creek plant of the Detroit Edison Co., and to celebrate its completion a dinner party was given inside the furnace of the boiler on Saturday evening, Nov. 28, at which 46 guests sat down. There was ample room inside to have seated at least a dozen more people with comfort.

Those present at the dinner were the officers and directors of the Detroit Edison Co., with their wives, the members of the construction force, and a few guests present by special invitation. Mr. Alex Dow, President of the Detroit Edison Co., is the central figure in the group. To prepare the boiler for the festal occasion, a wooden floor was built over the stokers and the tubes overhead were concealed by festoons of ribbon.

The boiler is rated at 2355 hp., but it is capable of furnishing sufficient steam for the development of 10,000 kw. of current by the turbine generators. The approximate exterior dimensions of the boiler are 30 ft., depth, width and height.

The boilers were built by the Babcock & Wilcox Co.

DINNER PARTY INSIDE THE FURNACE OF BOILER NO. 2, CONNORS CREEK PLANT, DETROIT EDISON CO., NOV. 29, 1914

A New Species of Engineer is reported from England, where a firm advertises in the London "Times" as "Laundry and Cooking Engineers." What is doubtless meant is that the firm in question specializes in the design and installation of machinery for use in laundry and large culinary establishments in hospitals, hotels, etc. There is no apparent reason why the design and installation of such machinery is not as legitimate a field for an engineer's expert services as the design of machinery for power development or for cutting metal, but it is doubtful whether in this country, at least, such designers and constructors have risen to the dignity of separate nomenclature.

Field and Office

Lowering a Submarine Pipe by Piledrivers

An interesting piece of submarine pipe laying recently completed was the laying of a 16-in. main across the west fork of the Chicago River in Chicago (near Hoyne Ave.) for the International Harvester Co. The purpose was to extend the high-pressure fire-protection system from the main plant on the north side of the river to the lumber yards and other parts of the plant on the south side. The

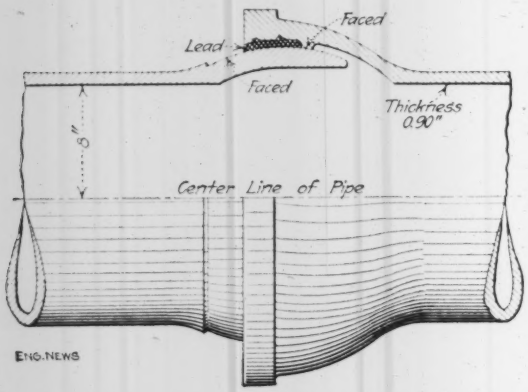


FIG. 1. FLEXIBLE JOINT FOR SUBMARINE PORTION OF HIGH-PRESSURE FIRE-PROTECTION MAIN AT CHICAGO

river is about 200 ft. wide, and the pipe is laid 25 ft. below the water surface.

About 20 ft. of dock was removed on the north side of the river and a dipper-dredge outfit then dug a trench across the river to a depth of 25 ft., carrying the excavation well back of the dock line on either side of the river to receive the inclined portions of the submarine main. Some hard digging was encountered in the lower part of the trench, though the upper part was of slushy material.

The main, 16-in. inside diameter and about 225 ft. long, was of heavy cast-iron pipe for a working pressure of 100 lb. per sq.in. It was made up in the usual 12-ft. lengths, but with the special flexible joints shown in Fig. 1. It was assembled in horizontal position on two deck scows, falsework being erected at the extreme ends of the scows to receive part of the inclined portion of the pipe.

The two scows, with pipe assembled, were floated to a convenient dock on the river, and four floating piledrivers were placed alongside. Four sets of bridles, made of 1-in. cable, were lashed to the pipe and fastened to the pulling blocks in the leads. (Although the piledrivers were fitted for much heavier lift, the pipe was handled on the pulling blocks as it was thus more easily manipulated.) The pipe was then lifted off the scows and hung on the leads. The scows were removed and the drivers swung around in position for lowering the pipe, as shown in Fig. 2. This operation required careful manipulation of the lines to get and hold the piledrivers in position.

The pipe was lowered in the water about 8 to 10 ft. and held there while messenger lines were put out from the leads of the end piledrivers, and additional lengths of pipe were set in place at each end (to lengthen the inclined portions). These joints were made with lead gaskets. Then the pipe was lowered about 8 ft. more and the ends again lengthened, until finally the main was in position in the bottom of the trench. The diver had trouble in releasing the bridles from the pipe on account of the amount of slush that had run into the trench.

When the pipe was in place, it was tested under hydraulic pressure at 150 lb. per sq.in. The dock wall at

FIG. 2. LAYING A SUBMARINE PIPE IN THE CHICAGO RIVER BY MEANS OF PILEDRIVERS

(The pipe was connected up on scows, and lowered by four piledrivers. Additional sections were added to the inclined end portions as the sinking progressed.)

the north side was then reconstructed, and connection was made to the pipe systems on both sides of the river. The work was done last summer by the Great Lakes Dredge & Dock Co., of Chicago.

A New Sampling Outfit for Bacterial Samples

By Robert Spurr Weston*

Frequently bacteriological samples of water, sewage, milk, etc., must be collected during warm weather. At such times it is necessary to transport them to the laboratory under conditions which as far as possible will prevent growth. For this purpose, many engineers and analysts have packed samples in ice, or in ice and saw-

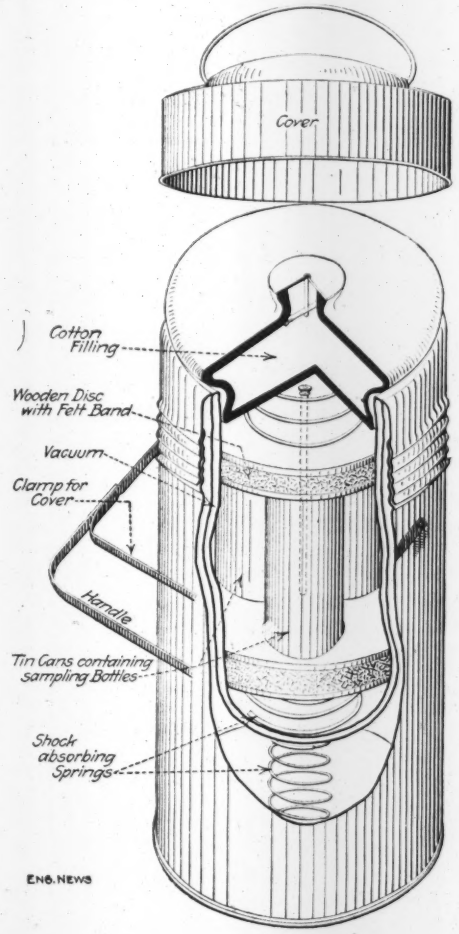


Fig. 1. Vacuum Jar for Use in Collecting Samples for Bacterial Examination

dust. Recently, there has come into use a device based on the fireless-cooker principle, which, though very satisfactory, is rather large, especially for a small number of samples, and, on account of its weight, costs a good deal to ship by express.

Recently the writer has made use of vacuum jars of various sizes with success. These can be arranged to hold from one to eight of the ordinary 2-oz., salt-mouthed, glass-stoppered bacterial sample bottles, inclosed in screw-capped tin cases. The following is a description of the outfit for three samples.

The isometric sketch, Fig. 1, shows the arrangement of the parts, and the view, Fig. 2, shows the parts separately. In a stock quart "Hotakold" jar is placed a holder for three tin cases. This holder consists of two disks of wood or metal with a band of felt at the edge so that the disks will make a loose fit with the sides of the jar. The disks are provided with circular depressions for receiving the bottoms and tops of the tin cases and a brass bolt with a thumb nut is used to secure them in place. By loosening the nut, the cases can be quickly removed from the holder. The holder moves freely within the jar, and is held in position by two springs at top and bottom respectively.

When shipped by express, the whole outfit can be placed

Fig. 2. Parts of Outfit for Collecting Bacterial Samples

(1) Vacuum jar, with metal cover removed and vacuum cover lifted. (2) One of the shock-absorbing springs. (3) Tin case and screw cover with the top of the sample bottle sticking out; the bottle is covered with the usual cloth cap. (4) Holder, with two cases containing bottles in place.

in a willow basket or a box. It is a very convenient apparatus to carry around, and may be covered with a cloth bag or leather case. A few lumps of ice placed in the bottom of the jar keep the samples at a low temperature for hours.

The apparatus above described weighs only 6 lb.

Building Gravel Roads in Logan County, Illinois

By John I. Miller*

We start the construction of a gravel road exactly as we would the improvement of a dirt road. Of course, the most essential thing is thorough drainage both by tiles, if necessary, and by shaping and crowning the subgrade exactly the same as if it was to be the wearing surface. With such a base for the gravel, water will not lie on the surface of the road at any place or in the side ditches.

First Gravel Coating—The next step is to haul the gravel and place it along the center of the road, about 1 cu.yd. to 10 or 12 lin.ft. of road, or 528 loads per mile. In Logan County, the gravel is generally donated by generous land owners, and this first layer does not cost more

*Consulting Sanitary Engineer, 14 Beacon St., Boston, Mass.

*Commissioner of Highways of East Lincoln Township, Logan County, Lawndale, Ill.

than $320 per mile for hauling. The gravel is then left to be spread and beaten down by traffic. It will slowly be shaped into a smooth, even surface—about two years' time is required.

SECOND GRAVEL COATING—When the first layer has become compacted, we follow this course with another, using the same amount of material; also leaving it to be spread and compacted by traffic. At the end of another year, the road is hard and compact and usually of a width of about 16 ft. The cost of this kind of a road seldom exceeds $640 per mile, but this does not include all of the cost, because of material and labor donated, as above stated. Charging the value of the donations, the cost would probably be 25% more.

MAINTENANCE—The continual upkeep of this kind of a road is only nominal. The regular four-horse "King" drag is all the equipment which will be necessary. There may appear "spring" spots where water collects at the surface, or a hole may appear where the gravel has sunk into the subgrade. These are promptly repaired by dumping one or more loads of gravel on these spots, or as much gravel as experience shows to be necessary.

My experience has been that such a gravel road as the one described is a great favorite in the black muck fields of Logan County and is so reasonable in cost that we may improve at least 10% of our roads per annum.

Razing a 400-Ton Brick Chimney

The construction of tall chimneys has from time to time been discussed in engineering publications, but little has ever been written about the most efficient method of chimney destruction.

An interesting work of this character was performed in San Francisco on Oct. 21 last.

Immediately after the San Francisco earthquake of 1906, the cable street railways of the United Railroads were converted into electrically operated lines. This led to the abandonment of numerous steam plants which had been used to operate the cable roads. Among these was the power house situated on McAllister St. between Central and Masonic Ave. The brick chimney for this plant was originally 125 ft. in height with a square base 14x14 ft., 12 ft. in height, surmounted by a circular niched superstructure that tapered to a diameter of 10 ft. at the top. It was built 30 years ago. The quake of 1906 shook

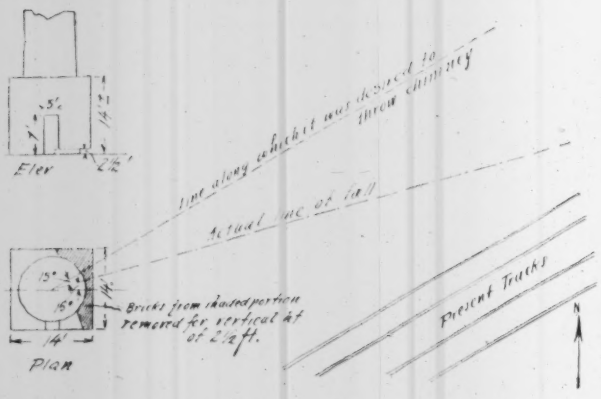

Line along which it was desired to throw chimney
Actual line of fall
Present Tracks
Bricks from shaded portion removed for vertical lift of 21 ft.
Plan

FIG. 1. SKETCH PLAN OF CHIMNEY, SHOWING DIRECTION OF FALL

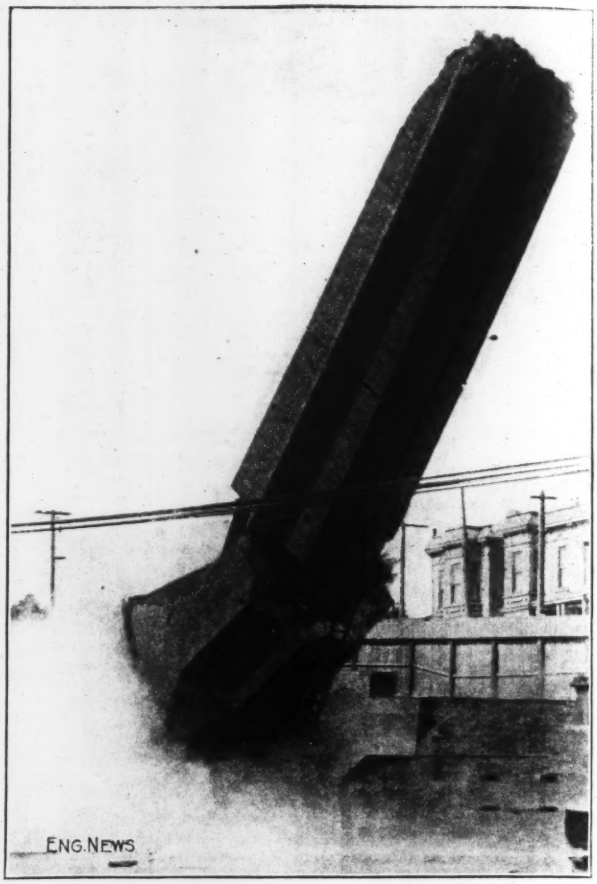


FIG. 2. RAZING A 400-TON BRICK CHIMNEY, SAN FRANCISCO, CALIF.

off the top a 25-ft. section. It was calculated that the 100-ft. section still standing weighed 400 tons.

As the city expanded and the vicinity of the power house developed into a residential section, the unsightly unused stack with its fractured top was regarded as a disfigurement to the neighborhood, so the street-railway company was asked by the residents to remove the structure. Accordingly the chimney was razed in the following manner:

It was desired to throw the chimney along a line approximately N 60° E, in order to parallel the tracks of the present electric road, which run in that general direction at a distance of about 40 ft. from the base of the chimney. A section 2½ ft. in height extending through the chimney to the east of its center, in the direction shown on diagram, was removed with gads from the base of the chimney. Seven 10x10-in. by 2½-ft. pine blocks were loaded at the ends with two vertical sticks of dynamite, one 2½ in. long in the top and another 3½ in. long in the bottom. The fourteen caps that were to discharge the dynamite were connected by wire so that the charge could be set off by electricity. The loaded and primed blocks were then placed vertically in the aperture gadded through the walls, and the blast was fired. Due to the opening for the doorway in the south wall, the chimney fell almost due east. In falling it separated into three sections, as shown in the accompanying photograph. On striking the ground these shattered, the frag-

ments all being thrown forward in the direction of the fall, for a distance of about 200 ft. from the base of the chimney. A few reached the tracks of the adjoining line above referred to, but were removed and traffic resumed in less than five minutes.

The razing of the stack was performed under the direction of B. P. Legare, Chief Engineer of the United Railroads.

Special Outrigger for Driving Piles under Trestles

A special outrigger designed for putting down piles in restricted quarters or where it is desired that the piles be inclined in any direction, was used in building the pier footings for the new steel bridge of the New York & Long Branch R.R. (C. R.R. of N. J.) across the Shrewsbury River, at Red Bank, N. J. The device consists of a movable steel frame pivoted on an ordinary piledriving machine, at about two-thirds the height of the leads (Fig. 1). The frame can be inclined in any direction by means of the pivot shown in detail (Fig. 2).

The driving is done by an ordinary ram whose rigging is simple: The line is run to a pulley at the top of the frame and down under another pulley near the pivot, thence leading back to the hoisting engine. Of course, a steam hammer could just as easily be hung in the channel ways. A battered group of piles, 16 ft. in diameter at low water, can be driven without moving the float.

The new Red Bank bridge was built partly under an old two-track wood trestle (the first half taken down was 20 yr. old; the second half, 40 yr.), one track of which was continued in operation. The contractor was not allowed to use this structure either in handling material or as a base for his plant equipment. This difficult condition led to the development of the rig described.

The outrigger was designed by John Anderson, contractor, 90 West St., New York City. When the rig was used on the Red Bank bridge, Mr. Anderson was general superintendent for G. B. Spearin, New York City.

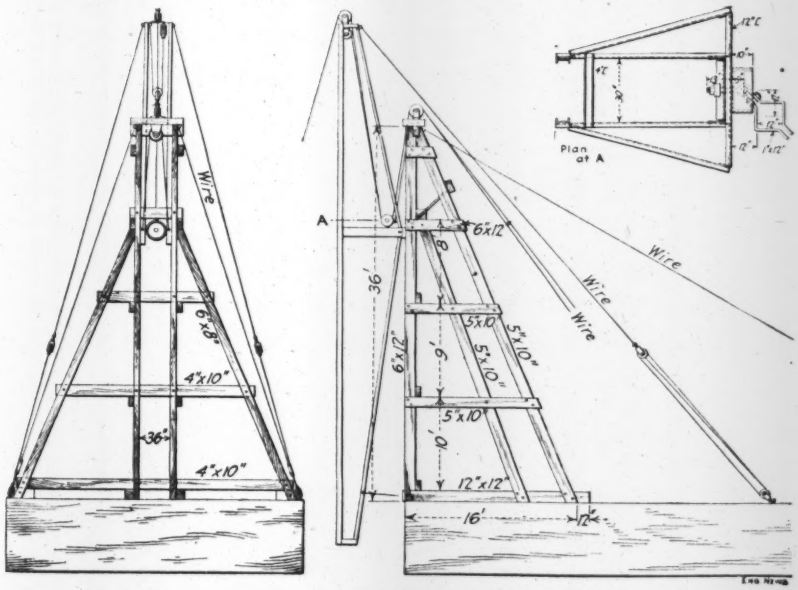


FIG. 2. GENERAL DESIGN OF FLOATING PILEDRIVER WITH SPECIAL OUTRIGGER

(Detail in upper right shows method of pivoting frame to stationary structure.)

A Large, Long Reinforced-Concrete Flume of Catenary Section

The following interesting description of a remarkable irrigation flume, with cogent reasons why a flume instead of a siphon was used, and why a catenary section was adopted, is taken from an address by H. B. Muckleston, Assistant Chief Engineer, Department of Natural Resources, Canadian Pacific Ry., delivered before the recent International Irrigation Congress at Calgary, Alberta. The flume is a part of the eastern section of the

FIG. 1. SPECIAL RIG DRIVING PILES UNDER A TRESTLE, AT RED BANK, N. J.

Canadian Pacific Ry.'s immense irrigation system southeast of Calgary.* We quote from Mr. Muckleton's paper as follows:

> The outlet at the north end [of the large storage reservoir] supplies the Bantry canal system, which irrigates 120,000 acres. About four miles from the reservoir this canal comes to a cross valley, and here was met the toughest engineering problem encountered in the design of the whole system. It was required to convey 900 cu.ft. of water per sec., or 330,000 gal. per min., across a valley two miles wide and 60 ft. deep, crossing the main line of railroad on the way, and do it with as little expense as possible, coupled with the least loss of elevation. The solution of the problem has resulted in a structure which has no parallel on this continent, or anywhere else.
>
> In cases of this kind there is always the choice between a flume and a siphon, and the designer can properly decide after a careful analysis of all the conditions and circumstances. When there is plenty of head available, especially if the depth of the valley is comparatively great, a siphon is usually the cheaper in the long run, though not necessarily so in the first cost. But when the available head is restricted a siphon frequently involves either a single pipe so large that it is impracticable or else a number of smaller pipes are required, which not only runs

*See "Engineering News," Apr. 27, 1905, for general description of the whole system; Aug. 8, 1912, for notes on the progress of the system; and Aug. 27 and Sept. 3, 1914, for a description of the 7000-ft. dam across and alongside the Bow River to divert water for the eastern section.

up the cost very rapidly, but also involves a prohibitive loss of head, and consequently a flume is usually preferable, provided the valley is not too deep.

Owing to the size and importance of this crossing it was desired to take no chances with fire, and for reasons of durability a reinforced-concrete structure was preferred over steel if it could be had within reasonable cost, so designs were worked out using this material.

Most flumes are rectangular if built of wood, and semicircular if built of iron or steel, in the latter case being suspended from girders instead of supported by them. In designing this flume, the suspended steel flume was taken as a model, but instead of using a semicircular section, which is convenient but incorrect, the proper section was chosen; that is, the same section as the flume would assume if it were made of a flexible material like canvas instead of a rigid material like steel or concrete. Distortion of a semicircular steel flume under load does no particular harm because the material can stand it, but with a concrete shell excessive distortion would certainly result in cracks, so the shell was given the correct shape in the first place.

The water channel is 21 ft. wide on top and 8.7 ft. deep at the center. The concrete shell is only 5 in. thick. The under part or substructure which supports the actual water channel is also of concrete and consists of a series of braced towers 20 ft. apart, carrying reinforced-concrete girders, from which in turn the concrete shell is suspended.

The problem was complicated by the existence of the main line of the Canadian Pacific Ry., which crosses the aqueduct diagonally near the eastern end. The track is too high to admit of taking the flume over this railway, so it had to go beneath, and is accordingly taken under the railway by a concrete pipe 9 ft. in diameter.

The total fall in the two miles of flume is a little more than 4 ft., which gives a velocity of nearly 8 ft. per sec., or about 6 mi. per hr.

A Condition Gage for Centrifugal Pumps

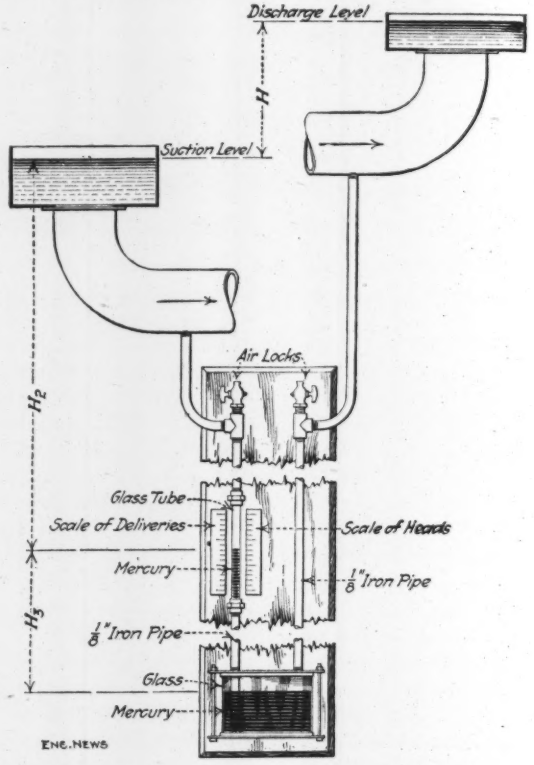
By George M. Peek*

Some means was found desirable of quickly finding the condition of centrifugal pumps in the Chain of Rocks station of the St. Louis water-works. Since the water carries considerable abrasive material, there is apt to be excessive wear, particularly in the labyrinth rings, with reduced delivery and efficiency. The condition of reciprocating units can easily be determined, knowing only speed or strokes (giving total plunger displacement) and metered discharge. (Each pump here discharges through Venturi meters.) But with centrifugals at constant speed, the delivery varies considerably with the head.

At this station, the net head varies between 46 and 65 ft., with the river stage and with the amount of water pumped (due to varying friction loss in intake). The two centrifugal pumps here have each a capacity of 40,000,000 gal. per 24 hr. against 56 ft. The pumps were tested when in first-class condition and delivery-head curves were plotted. A gage has been set up to show net head and expected delivery, so that a comparison with the Venturi reading gives at once the departure from best condition.

The accompanying drawing shows the arrangement of the gage. The mercury well was made by clamping two steel disks on a 3-in. lubricator glass. The glass tube has a bore of about $\frac{3}{16}$ in. Since the area of a $\frac{3}{16}$-in. tube is a very small quantity when compared with that of a 3-in. lubricator glass, the error due to change of mercury level in the well for the total range is negligible; therefore the scale of heads was permanently mounted on the board. The scale of deliveries determined from the test curve was mounted opposite. The graduations on the scale of heads were based on 1.13 in. of scale per foot of water head (ratio of inches of mercury to feet of water), corrected to 1.047 for the excess depth of water in the discharge-pressure leg (H_3 in the drawing).

In case there were a suction lift on the pump, instead of a suction head as we happen to have in St. Louis, it would be necessary to connect the air cock on the suction side to the air pump or some other means of exhausting any air which may accumulate in the tube above the mercury column.



A Net-Head Gage for Indicating Condition of a Centrifugal Pump

Trouble was experienced with the Venturi meters in this station by the dirty water leaving deposits in the manometer mercury chambers. This trouble was eliminated by making a connection with the clean-water pressure mains to the pipes connecting the upper parts of the mercury chambers with the throat and large part of the Venturi tube. In order to prevent deposits of dirt in the mercury chambers, valves are opened when the pumps are started and at such other times as may be necessary, thereby washing all dirt from the connecting pipes.

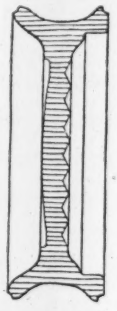
*Engineer-in-Charge, Water-Works Construction Department, St. Louis.

Philadelphia Municipal Water-Works Employees—The matter of caring for employees grown old in the service and no longer able to perform the duties for which they are paid has become of increasing importance. The oldest regularly paid employee in the Water Bureau is 88 years old. Forty-eight employees, or about 4% of the total, are 70 years or over; a much larger number are between 60 and 70 years old. The present practice is to continue an employee at full pay until long after he can perform his full duties, and often indefinitely. The work of the bureau requires that the bulk of the employees should have reasonable physical vigor and activity, as well as skill and experience.—Report of Chief of Bureau of Water.

Partitions of Translucent Pressed-Glass Units

Glass units for building partitions of translucent, yet unclouded glass—units held in place by practically invisible joints of reinforced cement-mortar—were recently introduced into the United States. Keppler pressed-glass partitions have been known in Europe for several years. Fig. 1 shows a completed partition built of the sort of units shown in detail herewith.

The glass is very strong, being double-annealed. It is made in 6x6-in. and 8x8-in. sizes and weighs, erected, 10 to 15 lb. per sq.ft. The glass is either clear or amber, although it can be supplied in any color.



In a fire test by the Royal Testing Station, Berlin, a window of this glass was subjected to a temperature of over 1800° F., reached in 30 min., and maintained thus for a half-hour, when water at ordinary hydrant temperature and pressure was played upon the heated glass. Fig. 2 shows the window before and after the test.

The glass is formed in such a way that while admitting the maximum light, objects a few feet distant from the other side are indistinguishable. This type of construction is also practically soundproof.

The units are furnished with the concave ends painted white and a layer of asphalt over the paint. Light striking the cement frame is reflected into the room by the white surface. The asphalt permits expansion of the units.

The units are laid up in the same general manner as is terra-cotta tile, and any bricklayer is capable of performing the work. Reinforcing rods are placed both in the horizontal and the vertical joints. The total cost of completed partition varies from $1.20 to $1.50 per sq.ft.

The glass for these partitions, and for other constructions as well, is furnished by Keppler Glass Constructions, Inc., 101 Park Ave., New York City.

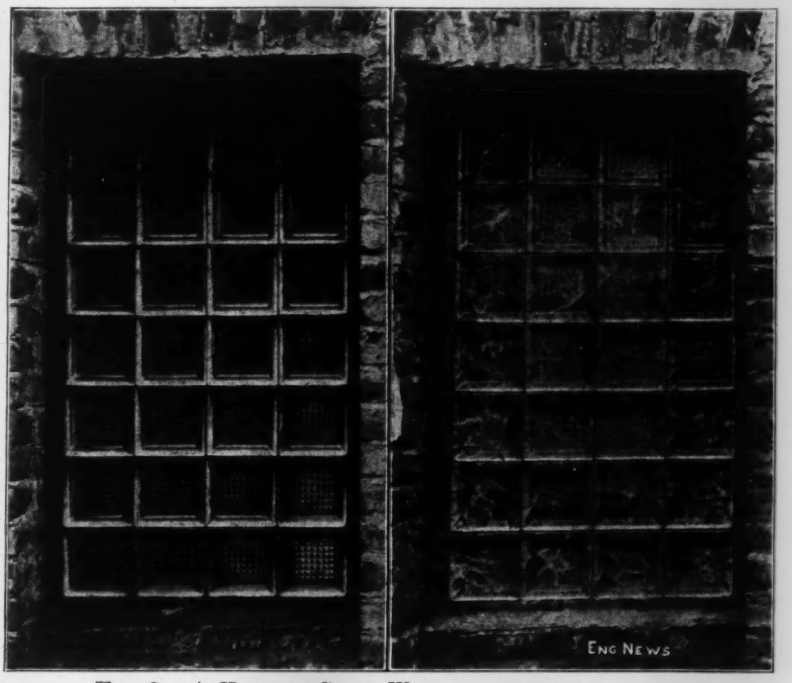


FIG. 2. A KEPPLER-GLASS WINDOW BEFORE AND AFTER FIRE TEST TO 1800° F.

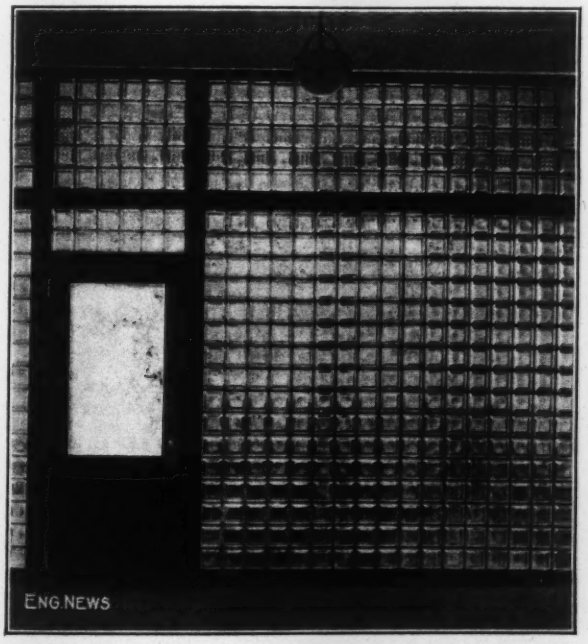
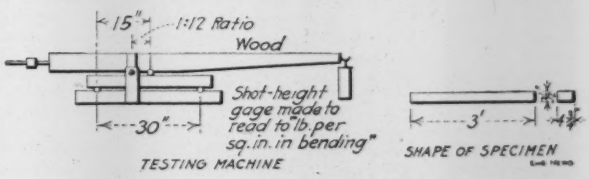


FIG. 1. A PARTITION BUILT OF KEPPLER-GLASS UNITS

A Concrete Field Testing Machine

A very simple testing machine is now in use on the new Welland Ship Canal in the investigation of the strength of field concrete. It is not claimed that the machine is very precise, but it does give a simple method of judging comparative strength of the various concretes being used over the length of the work.

Concrete samples are taken at the mixer and rammed into portable molds giving pieces 36x4¾x3½ in., unreinforced. These pieces are brought into the main office and stored for varying periods and are then broken in the simple leverage machine illustrated in the accompany-



CONCRETE FIELD TESTING MACHINE

(Testing machine for field samples of concrete, Welland Ship Canal.)

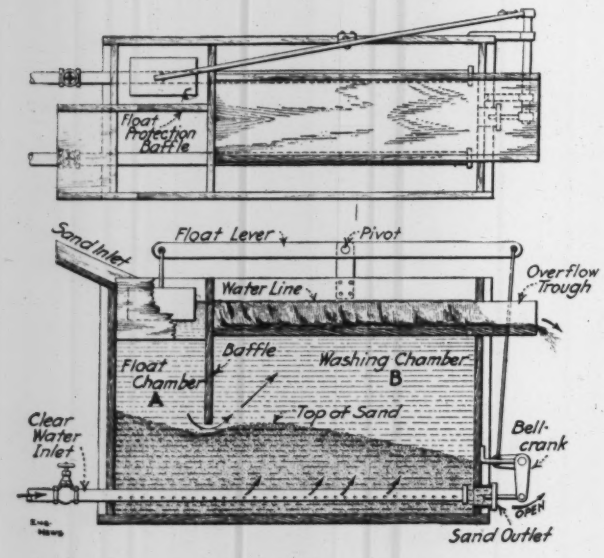
ing drawing. The weight at the end of the lever is procured by pouring uniform-size shot into a bucket and the breaking stress in bending (lb. per sq.in.) is read directly on a gage which measures the depth of shot in the bucket but which is scaled to read directly in pounds per square inch. The frame is all of wood, except the steel pins and fulcrum. The leverage is 1 to 12. Comparative records are kept of the breaking stress of different pieces, the record giving age of specimen, mix, history of ingredients and location of work from which specimen is taken.

NOTES

An Improved Automatic Sand-Washing Box—The accompanying sketch shows the essential parts of a sand-washing-box discharge valve and an arrangement designed to overcome some of the difficulties of discharging described in the excellent article by W. H. Wilms on the operation of sand and gravel plants in the Nov. 19 issue of "Engineering News." This device, in addition to being automatic, avoids the spilling of muddy water with the sand, at the cost, however, of supplying clear water unmixed with sand at the bottom of the box, as well as with the sand in the usual way.

The washing box itself consists of a rectangular box with an overflow trough extending about three-fourths its length, placed with the top a few inches below the top of the box. Water overflows the entire length on both sides of the trough and wastes at the end of the trough. At the inner end of the trough a baffle is made from side to side of the box, extending from the top about halfway to the bottom.

The mixed sand and muddy water enter the open space between this baffle and the end of the box, in which is also a float, shown in the illustration, protected somewhat by a low baffle, to prevent too much agitation of the surface water. At the bottom of the trough are two or three water pipes perforated on the lower side by ¼- or ⅜-in. holes to admit



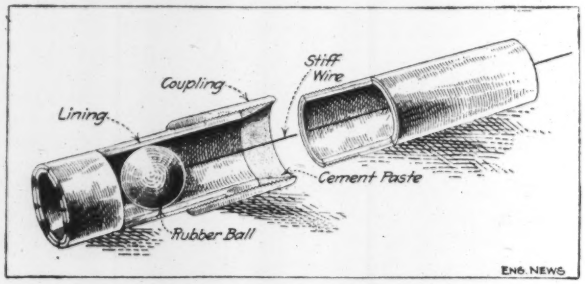
AN IMPROVED AUTOMATIC SAND WASHING BOX

water uniformly over the bottom of the box. The float is connected with a sand-discharge valve, so that when the float is raised it opens the valve.

In operation, the sand and water enter through A, the water escaping through B, and the discharge valve remains closed until the sand in the bottom of the box reaches about the bottom of the baffle, or a little above that point, when the restricted passageway under the baffle begins raising the water surface in A (which it does rapidly), thus raising the float and opening the sand-discharge valve. Then the water entering through the bottom is of course passing up through the sand, driving muddy water ahead of it, and is practically floating the sand in the box, or at least keeping the mixture of sand and water in a fluid state. This mixture, being much heavier than the muddy water alone, maintains more or less of a level surface, preventing the muddy water from reaching the outlet until the said is nearly all out, or the valve is closed, which is adjusted to close after lowering the sand in the box 2 or 3 in.

In operating this box we found it to be well adapted to removing fine grades of sand from the washed product. Of course, it took every grade from the coarsest to dust, and when operated slowly made a very clean sweep of it, much better, I think, than mechanical screening would ordinarily do without excessive cost; but as this was of no particular value to us, it was not investigated further. The sand used in this washing box averaged much finer than the analysis of torpedo sand given in the article mentioned before, but had about the same maximum sizes.—T. R. Martin, Cincinnati, Ohio.

A Cement-Lined Joint for a Cement-Lined Pipe was described by J. D. MacBride, manager of the MacBee Cement-Lined Pipe Co., of Boston, Mass., at the November meeting of the New England Water Works Association. The one fault found with cement-lined pipe, in the meeting's discussion on service pipes, was the difficulty in getting a protected joint, for, although the coupling may be cement lined, there is no assurance that there is not an opening at the end of the thread where water will come in contact with the iron and cause corrosion. On a recent piece of work Mr. MacBride was asked to guarantee a fully protected joint, and the accompanying sketch shows how he made the joint.



METHOD OF MAKING A CONTINUOUS CEMENT-LINED JOINT IN CEMENT-LINED PIPE

A hard-rubber ball of the same diameter as the pipe was inserted in the length of pipe to be added to. To the ball was attached a stiff wire, which was passed through the length of pipe to be added. The inside of the coupling, threads and all, was then coated with cement paste and the pipe length screwed on, after which the ball was drawn ahead to the next coupling. This insured a continuous cement-lined surface on the interior of the joint and obviated the difficulties met with in the ordinary joint.

Motor Trains for Railway Construction Gangs have been operated on the Chicago Great Western Ry. as a means of carrying the men rapidly between their work and the camp. The motor car used is more powerful than the ordinary motor section car, having a four-cylinder gasoline engine, and it can haul two push cars with a crew of 43 men on the three cars.

A Eulogy on a Hard Working Government Engineering Bureau is given in the following words by Secretary of Commerce Redfield in his recent annual report:

The duty of the U. S. Coast Survey deals first with humanity and second with commerce. Its work comes foremost in the protection of life and property along our shores and in opening the way for trade; yet after an experience of 20 months I affirm, without fear of successful contradiction, that the past attitude of the Government toward the Coast and Geodetic Survey, if the magnitude of its task be considered and the quality of its work be weighed, has been both with respect to its housing, its vessels, and to the necessary apparatus for its serious tasks, and particularly as regards the Pacific coast and Alaska, like that of a wealthy and prosperous man refusing to give his loyal children the necessaries of life. These are strong words. They are amply justified. Their truth cannot be successfully challenged. Our citizens have been drowned (31 in one case) and both private and public property repeatedly lost because the United States Government has not more rapidly provided the force and apparatus with which to survey and chart the dangerous waters of our Pacific and particularly of our Alaskan coast.

Editorials

Long-Term Highway Bonds

The reckless financial policy of building perishable roads and pavements with borrowed money obtained by issuing long-term bonds, not to be paid off until after the destruction of the work for which the money was borrowed, has often been condemned by engineers. Many counties, cities and states, nevertheless, are still continuing the practice of creating a debt which a future generation will have to pay although little will be left at that time of the improvement which the debt paid for. Engineers, of course, recognize on the other hand that a certain portion of the expense in constructing a road is laid out on work of a permanent character, to pay for which the issue of long-term bonds may be justifiable.

The Department of Agriculture has just issued a bulletin entitled, "Highway Bonds," in which an estimate is made of the percentage of cost in construction of different types of improved roads which is expended on its foundation, such as drainage, grading, etc., and the percentage which is expended on the surfacing which must eventually be renewed. These figures are said to be based on a study of 244 different types of roads. A summary of the figures in this bulletin shows that on a typical gravel road 20 ft. in width, costing $4400 a mile, the expenditure on the foundation features, such as drainage and grading, will be 41% and on the surfacing 59%. On a water-bound macadam road 15 ft. wide, the foundation features cost 37% and the surfacing 63%. On a bituminous macadam road 15 ft. wide, the foundation features cost 27% and the surfacing 73%.

Of course, the above figures represent merely broad averages and the bulletin points out that part of the cost of the surfacing, the foundation course for example of a telford road, may also be regarded as a permanent investment. Bearing this in mind, it is estimated that on a water-bound macadam road, 62% of the cost might be regarded as a permanent investment, and on a bituminous macadam road about 56%.

It is to be hoped that a wide circulation of this bulletin may have some influence toward checking the indiscriminate issue of long-term bonds for road building purposes. In a number of states in the West especially there has been a carnival of extravagance in the issue of county bonds for highway work, and much of the money thus raised has been expended in a manner which will leave little benefit in the way of improved roads to be found after a very few years.

⁂

Eliminating Politics from New York Highway Work

"A study of the legislation relating to the New York State Highway Department clearly shows that this department has been looked upon in the past as a great political machine." This statement is made by John M. Carlisle, State Commissioner of Highways of New York, in a recent letter to the New York *Times,* in which he points out that during the past ten years there have been seven different heads of the New York Highway Department, and says "it is remarkable that as good results as have been secured have been attained under such a system."

In order to do away with this constant tinkering with the Highway Department by legislatures of changing political complexion, Mr. Carlisle urges that the coming Constitutional Convention in New York should make the headship of the Highway Department a constitutional office, with a term of at least five years in case of a single commissioner, or of six years in case a commission of three members is established, with one member going out of office every two years.

Mr. Carlisle's recommendations ought to carry great weight. Engineers, at least, realize that the first essential to economical and efficient work in highway construction and maintenance is the creation of a permanent working organization, to be conducted without regard to politics. It is well nigh impossible to create such an organization if its responsible head is subject to change for political reasons at every election.

⁂

A Suggestion for Water-Works Valuation

An interesting discussion of this question was recently given by J. W. Ledoux, Chief Engineer of the American Pipe & Construction Co., in a paper entitled "Some Observations on Water-Works Valuation" read at the Atlantic City meeting of the Pennsylvania Water Works Association.

Mr. Ledoux is an engineer of long experience in water-works construction and operation. He estimates that the average appraisal for the total value of a going water-works plant should be in the neighborhood of 183% of its physical cost. Mr. Ledoux distributes this allowance as follows, and states that the percentages are the result of his judgment based on a considerable amount of practical experience:

Physical cost, 100.
Promotion, 2½.
Organization expenses, 2½.
Engineering, 3.
Financing, 18.
Legal expenses, 2.
Rental or cost of construction plant and housing of employees, 2.
Contingencies, 10.
Interest during construction, 5.
General contractor's profit, 15.
Development cost, 20.
Allowance for useless items, 3.
Total, 183% of the physical cost.

It will be noted that the two largest items in the above table are financing and development expenses. Regarding the first, Mr. Ledoux says that in selling bonds to obtain money for construction, the usual method in financing private water-works, 90 is about as good a price as the water companies can expect to obtain from the bond houses. As the final cost of the plant must include all

the other items as well as the physical cost, it may be assumed that the total amount to be provided will be 165% of the physical cost, and dividing 165 by 90 the total expense of financing will be 18% of the physical cost of the plant.

Regarding the 20% allowance for development cost, Mr. Ledoux says this will be more often exceeded than not. A public utility must, like any other business enterprise, gradually acquire its customers, and must expend a certain amount of energy and expense in order to obtain them, oftentimes finding it necessary to operate at a loss or at reduced profit for a time in order to do this.

The allowance of 3% for engineering expenses will be generally agreed to be extraordinarily low. Even for plants of considerable size, 6 or 7% would be not an extravagant allowance.

It is worth noting that most of the items included in Mr. Ledoux's statement above apply to a municipally constructed plant as well as to one built by a franchise company. The only items that would not be at least as large in a city-built plant would be those for promotion, organization expenses, and financing. The promotion of a city-owned plant may be done as a matter of public spirit; but there will generally be some outlay for financing, as many cities have to allow some commission to brokers in order to dispose of their bonds.

Wanted: Engineering Promoters

There is one profession, if we may call it a profession—although most people would doubtless call it a business and many of them a bad business—the ranks of which are seldom overcrowded. We refer to the profession, art or calling of promotion.

It is termed promotion for want of a better name; and, unfortunately, the name carries with it very nearly an indictment of doubtful moral character. Yet it is strictly true that in practically every business enterprise of magnitude, and particularly in enterprises connected with engineering, somebody must do the work which is generally termed promotion; and on the way in which this work is done the success or failure of the enterprise will very often turn.

It is often said that an engineer is of no use as a promoter; he is too honest. This, however, is a cynical view and does not bear careful examination. Experience shows that the dishonest promoter, like the dishonest banker, while he may experience a brief period of abounding prosperity, very soon finds his occupation gone. Conditions in business and engineering have changed so vastly in the past 25 years that the old-time promoter, made famous by Mark Twain in his biography of Colonel Sellers, has become nearly extinct. The more guilty and less lovable type of promoter than Colonel Sellers—well illustrated by the vendor of glowing opportunities in King Solomon's Mines—has been pretty thoroughly put out of business by the operations of the Federal courts. With the disappearance of the class of men who made the name of promoter odious, it is worth while to call attention to the fact that the business of promotion, to the engineer who by his personal characteristics is fitted for it, is a field which offers very large opportunities.

One of these opportunities, for example, is advertised in the "Situations Open" columns of our current issue. A very large engineering enterprise of undoubted public benefit is to be carried forward. It is a public enterprise and not that of a private corporation; consequently, the public which is to eventually foot the bills must be shown that the project is a sound, safe and beneficial one. The men who are in charge of this large work are far-sighted enough to see that this task of public education is not a thing which can be done by spasmodic efforts, nor is it one that the ordinary engineer of high technical qualifications is at all fitted to perform. The man to fill this place, for one thing, must be a good speechmaker, able to talk before an audience at a public meeting, to meet and disarm criticism, and to convince those in attendance that he has sound sense on his side.

He must know how to practice the art of publicity; how to reach and interest the newspapers, not spasmodically but continuously. He should be a man whose personality is such as to command the confidence of the men whom he meets in all walks of life. Finally, he must be a man knowing at least enough about the technical engineering features of the project to be able to explain it clearly and convincingly to anyone and everyone, and to meet technical criticism from any source.

It will be evident that this specification is not easily filled. We allude to it here, not because of this one opening, but because it is typical of the class of openings that are available in many places for men with such qualifications as are described. It illustrates a class of opportunities open to young men in the engineering schools, provided they have the proper amount of natural talent on which to build, and this amount need not be as great as is sometimes thought. The reason why most lawyers are far better public speakers than engineers is undoubtedly because the lawyer, engaged in court practice at least, is continually cultivating the art of addressing an audience, while most engineers seldom have occasion to cultivate whatever talent they may possess in this field.

We are told that notwithstanding the fact that old graduates are repeatedly urging upon the boys in the technical schools that they should cultivate the art of writing good English and of excellence in debate, few of the engineering students take any interest in these branches of the curriculum. If they realized how largely abilities in this direction would aid in their progress toward success in active life, in comparison with their expertness in the technical work of their profession, there would doubtless be more earnest work in the English classes in our engineering schools.

Some Further Lessons from the Edison Conflagration

In connection with the conflagration in the manufacturing plant of Thomas A. Edison, at West Orange, N. J., so fully illustrated in our last week's issue, some further comment is justifiable, in view of the unusual character of the fire and the wide interest in its results.

A superficial observer who visits the scene of the conflagration, or who scans the photographs of the gutted buildings in our last week's issue, may perhaps get the idea that a reinforced-concrete structure is deficient in resistance to fire. Such an observer, however, who visited the scene of the conflagrations in Baltimore or in San Francisco, or examined the pictures of the fireproof buildings on the burned area that were fully shown in ENGI-

NEERING NEWS at the time, would likewise become firmly convinced that the steel-frame structure protected by fireproofing was deficient in its resistance to fire.

Our readers who do not recall definitely the occurrences in those fires can easily refresh their memories by turning back to our issues published at that time, and will find it interesting to compare the behavior of a number of the steel-frame structures there exposed with the condition of the buildings in the Edison plant.

It should be distinctly borne in mind that the destruction of the Edison plant is to be classed as a conflagration and not as an ordinary fire. The number of buildings involved, the juxtaposition to each other, the almost total absence of effective fire fighting make the conditions in the Edison plant strictly comparable to what occurs in a city conflagration. Further than this, it is altogether probable that the inflammable material contained in the Edison buildings burned more quickly and possibly produced a greater degree of heat at some points (though this latter is uncertain), than occurred in the Baltimore or San Francisco conflagration, where nearly all the steel-frame fireproof structures affected were office buildings containing only the usual amount of office furniture.

Some comment seems worth while also regarding the relative damage done to surface finish in the reinforced-concrete structures and the steel-frame structures protected by fireproofing. The office buildings in the Baltimore fire which passed through the conflagration with little structural injury, required renewal of practically all of their plaster finish on walls and ceilings, which was, of course, to be expected. A noticeable feature in the reinforced-concrete buildings at the Edison plant is the very small amount of injury done to the ceilings. In the manufacturing plant there was, of course, nothing in the way of surface decorations to be destroyed, but the behavior of this monolithic concrete surface under the severe exposure to fire is a notable testimonial to the excellence of good concrete construction.

From the description and illustrations in our last week's issue, it is evident enough that another of the lessons of the fire, to the engineer engaged in the planning of industrial plants, is the desirability of generous space between buildings, and further the provision of some resistance to the spread of flames in the shape of wire-glass windows, and fire-resisting division walls to divide up the large floor areas. It is quite true that most large manufacturing plants, especially those which have grown by successive increments, are much more crowded than considerations of safety would dictate, or even requirements of good lighting.

The plea is often made that the economy in inter-works transportation resulting from placing buildings close together offsets the increased fire risk; but with a plant equipped with modern methods of transportation, when material is once loaded upon a car or motor truck, it makes comparatively little difference if the length of haul from building to building is 100 to 200 or even 300 ft. greater.

Referring again to the general behavior of the reinforced-concrete structures at West Orange, it is to be remembered that these buildings were most of them four or five years old, and it is needless to say a great deal of progress has been made in the art of reinforced-concrete design during that period. It is altogether probable that expert analysis will show that in some respects the design of the buildings was not all that would be found in the work of first-class engineers at the present day, aside from the particular question of the column design, which was discussed in our last week's issue. That under these conditions the buildings made such an excellent showing is to be accepted as a testimonial to the fire-resisting quality of reinforced concrete.

Letters to the Editor

Mechanical Resuscitation Devices

Sir—In your issue of Dec. 3, p. 1109, you have a note entitled "An Efficient Method of Resuscitation." This note refers to the method developed by the U. S. Bureau of Mines. I have not had the pleasure of reading the report from which your article is abstracted, but I believe that some harm might be done to at least one perfectly safe and very useful resuscitating device if engineers should implicitly believe that part of the note which says "no mechanical artificial resuscitating device should be used unless one operated by hand that has no suction effect on the lungs."

This letter is prompted by experience with a device for resuscitating persons overcome by illuminating gas, which is entirely automatic and is only operated by hand in case the operator so desires. There is also no suction of sufficient force to cause the least danger to the lungs.

R. C. KELLOGG,
Civil Engineer, Brooklyn Union Gas Co.
Brooklyn, N. Y., Dec. 7, 1914.

More 1000-Ft. Dry Docks

Sir—I beg to call your attention to the omission of the Balboa Dry Dock, Pacific Terminals, from your list of dry docks over 1000 ft. in length, given in ENGINEERING NEWS, Nov. 26, 1914, p. 1064.

The Balboa dock is under construction and will be finished during the year 1915. The principal dimensions are:

	Ft.
Length over all	1110.0
Maximum length of ship dockable	1000.0
Width of entrance, clear	110.0
Width of body of dock at coping	140.0
Width of body of dock at floor	117.0
Depth, coping to floor	56.0
Height of keel blocks	4.5
Depth of water over tops of blocks—	
Mean sea level	35.0
Mean high water	41.5
Mean low water	29.3

RAY W. BERDEAU.
Resident Engineer's Office.
Paraiso, C. Z., Dec. 3, 1914.

[Since the article in question was written it has also been announced that the Pearl Harbor dock at Hawaii, for the United States Government, will be rebuilt for a

length of 1029 ft. It will be remembered that the foundations of that dock (then 831 ft. in length) failed during construction some years ago.

The two above noted dry docks and the projected docks of about equal length at Halifax, N. S., and North Vancouver, B. C. (noted in the Construction News sections of ENGINEERING NEWS, Dec. 3 and Sept. 24, 1914) show clearly that the "1000-ft. dry dock" is no longer a novelty. —EDITOR.]

The Chicago Flat-Slab Ordinance

Sir—Being particularly interested in concrete flat-slab design, the writer read with interest the Chicago Building Code on this type of construction, as given in your issue of Sept. 24, 1914, p. 632, and its subsequent criticism by Mr. Godfrey, Nov. 12, 1914, p. 993.

There is one point of inconsistency that the writer would like to call to your attention; that is, the case of rectangular panels. Where the difference between the length and breadth is less than 5%, the panel is designed as a square panel of average length; but for over 5%, a different procedure is resorted to.

The article in the code pertaining to the latter case permits of two different interpretations, the ambiguity possibly arising from an attempt on the part of the writers of the code, to combine the regulations for two-way and four-way reinforcement in the same article. An illustration of the procedure for each interpretation and its results are given below. First:

Let us assume a length 10% greater than the breadth; then for L = length and B = breadth, $L = 1.10\,B$ and the average panel is $1.05\,B$. The moment at the center of strip B (diagonal band) is

$$M = \frac{w\,L^2}{60} = \frac{w\,1.05\,B}{60}$$

The steel in the strip along length L is then taken at $\left(\frac{1.10}{1.05}\right)^3$ times that obtained by the above formula, which is equivalent to designing for a moment,

$$M = \frac{1.15\,w\,1.05\,B^2}{60} = \frac{w\,1.05\,B^2}{52}$$

On the other hand, if we were to take the formula for differences of 5% or less we would obtain for moment at center of strip A (crossband)

$$M = \frac{w\,1.05\,B^2}{40}$$

This difference is altogether too great to permit of a consistent design particularly where panels both rectangular and square occur in the same design.

The second and more likely interpretation assumes, that the strip A is to be designed for bending moment $\frac{WL^2}{40}$ where L is to be the average panel length; the steel required for this moment found, and multiplied by one-half the average panel length to obtain the amount of steel necessary for the band. The amount of steel required for each crossband of the rectangular panel is then found by multiplying by the quotient obtained by dividing the cube of the actual panel length by the cube of the average panel length.

This method will resolve itself into the following: Moment for center of strip A for average panel is,

$$M = w\frac{av.\,L^2}{40}$$

where $av.\,L$ = average panel length. The steel required would be given by formula:

$$M = w\frac{av.\,L^2}{40} \times \frac{av.\,L}{2}$$

For longer span L, steel required would be obtained from formula:

$$M = \frac{w\,av.\,L^2}{40} \times \frac{av.\,L}{2} \times \frac{L_1^3}{av.\,L^2} = \frac{w\,L_1^3}{2 \times 40}$$

which is the same as the moment for square panel of length L, and therefore independent of the other dimension. Similarly, for shorter span B steel would be given by formula:

$$M = \frac{w\,av.\,L^2}{40} \times \frac{av.\,L}{2} \times \frac{B^3}{av.\,L^2} = \frac{w\,B^3}{2 \times 40}$$

which is the same as the moment for square panel of length B.

If this is the intent of the code, it certainly could be much more clearly and simply stated; but it would give results almost as inconsistent as the other interpretation, particularly apparent in the case of the negative moments over the cap, where the moments would be $\frac{w\,L_1^3}{2 \times 15}$ and $\frac{w\,B_1^3}{2 \times 15}$ respectively, on adjacent edges of the caps, and for the limiting value of $L_1 = {}^4/_3\,B$ would require 2.4 times as much steel on one edge as that required on the adjacent edge.

As for Mr. Godfrey's criticism, it seems that although his censure of the omission of a provision for taking consideration of the bending in the columns is just, his attitude toward the slab design is not justifiable. Nobody can at the present time state what the exact theoretical moments in this type of construction are, but the criticism leveled at those stated in the code could be launched against ordinary two-way reinforcement with as much apparent justice. A consideration of the bending moments must include a consideration of the lines of inflection and those are entirely different in the various types of slabs and would account for the differences in the moments.

M. HIRSCHTHAL.

135 W. 141st St., New York City, Nov. 21, 1914.

Sir—The criticism "Flat Slab Indulgence," by Edward Godfrey, in your issue of Nov. 12, regarding the new provisions of the Chicago building ordinance for the design of flat-slab construction, should hardly be allowed to pass without discussion.

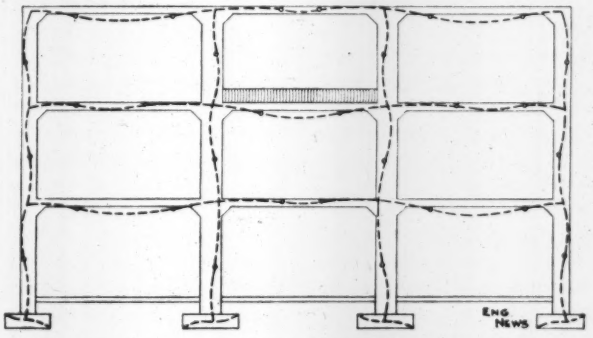
I have devoted twelve years to theoretical study and practical experience in the design and erection of all types of reinforced-concrete construction in Germany, France and the United States. Furthermore, I am not connected with any concern commercially interested in reinforced-concrete construction and, therefore, my conclusions may be considered as unprejudiced and based entirely on experience and science.

Mr. Godfrey's ideas may be divided into two groups: the first in criticism of the attitude of the Chicago build-

ing ordinance toward concrete construction in general; the second in criticism of the late additions to the ordinance respecting flat-slab construction. In order to maintain a scientific point of view, it is necessary to separate these two ideas strictly. I agree with Mr. Godfrey in the first instance; it seems surprising that the ordinance of a large progressive city like Chicago should not make more concessions to a scientific treatment of continuous-slab, beam, and girder construction, inasmuch as the best ordinances of most of the progressive countries do so. But with the second group of Mr. Godfrey's ideas, I must disagree. In my judgment the new additions to the Chicago building ordinance relating to flat slabs reasonably accord with scientific principles and the practical conditions governing the actual interior stresses.

Mr. Godfrey's first objection is to the paragraph regarding negative moments. If the designer reinforces the edge of the column cap where the effective depth is a minimum, he surely will be safe, because the increased effective depth of the column cap will always offset the increase in negative moment, and the experienced designer always will run the reinforcement across the column head in order to secure the necessary bond and to splice the rods at the points of inflection where the bending moment is a minimum.

The effect of negative moments on the columns is quite frequently overestimated by engineers. It requires, of course, a study of statically indeterminate stresses in



GENERAL DISTORTION OF A RIGID BUILDING FRAME UNDER LOCALIZED LOAD

order to value this influence reasonably. The sketch herewith shows that, under usual conditions where flat-slab construction is used, the negative moment is not taken care of by one or two columns, but by the entire structure. The four supporting columns are not only rigidly connected with the columns above and underneath, but are also connected by means of the adjoining slabs with the next two or three surrounding vertical rows of columns, thus forming a framed structure out of the entire building. The apparently large influence of the negative moments on the columns will become very small, being divided among so many different members of the structure. It is easily proved by analysis that the combined stresses due to bending and direct load will never, under normal conditions, exceed the stresses due to the maximum direct load.

As to Mr. Godfrey's criticism regarding the positive moments in the slab, the following may be stated. The assumption of support on two sides only is opposed to the fundamental principle of the square-panel slab, which is to support the slab on four sides. It is evident that the fractions given in the ordinance, to be used in determining the moments, are only a means to simplify the method of designing and checking. To satisfy himself every conscientious engineer will check up the suggested fraction. A thorough investigation will prove that a scientific determination of the moments, following the theory of elastic deformation of the material, in continuous and framed structures gives practically the same results as a design according to the regulations of the Chicago Building Ordinance. Everyone will agree that the final result is the important part of the design and not the method of arriving at this result.

Mr. Godfrey's supposition as to the method of deriving the empirical formulas for computing the interior stresses in flat slabs in this code are at least questionable and require no discussion.

CURT VON MUELLER,
Civil Engineer.

Chicago, Ill., Nov. 24, 1914.

Sir—In the article on the new regulations formulated by the Commissioner of Buildings of Chicago, for governing reinforced-concrete flat-slab floor design, it was stated that this ruling is the result of some four years' study and testing. According to information which I have, this new regulation does not differ materially from the tentative one which has been in force by the Chicago Department during these four years of study. This tentative ruling in substance was the so called McMillen formula, to which was added a definite requirement for the cantilever portion of the slab. The new ruling differs from the method used by McMillen (ENGINEERING NEWS, Mar. 31, 1910) in that the moment in the diagonal center of the panel for four-way system is 20% less, and that in the direct belts 20% more. It is to be supposed, therefore, that this change is the result of four years' study and testing by the Chicago Department.

It is not apparent to me, in just what way this new regulation is the result of test experience so far as same has been published. Tabulated below are values which are given for the steel stresses as measured by strain gages and as computed by this new Chicago regulation for five buildings, reports of the tests of which have been published.

SCHEDULE OF STEEL STRESSES

Names of Buildings	Test Load, Lb. per Sq.Ft.	Mid-Span Computed	Mid-Span Measured	Edge of Capital Computed	Edge of Capital Measured
		Lb. per Sq.In.		Lb. per Sq.In.	
Northwestern Glass Co.	400	25,800†	8,200		
		14,400	4,300	28,800	20,000
		26,400	6,900		
Deere & Webber Co.	340	10,000	5,100	27,700	20,700
		12,700	4,540		
A. J. Frank	250	7,500	1,070	8,050	4,575
		25,000	3,300		3,500
Larkin Co.	370	15,100	3,000	18,100	5,400*
		16,200			
Shredded Wheat Co.	191	19,000	19,000	25,500	17,000

*At edge of drop.
†Upper values for direct belt stresses; lower values for diagonal.

The results given are for the loadings in the respective buildings, which were uniform over several panels. The first two buildings are in Minneapolis, the second two in Chicago, and the last one in Niagara Falls, N. Y. Reports of tests of all these can be found in engineering literature.

It should be noted that the two Minneapolis buildings were designed with the old standard flared capitals without the depressed panels; the two Chicago buildings had depressed panels adding to the thickness of the slab in the

region of the columns; the Niagara Falls building also had a depressed panel, but this was so thin (2 in.) as to be of much less importance than those in the Chicago buildings. The Minneapolis and Chicago buildings are of the four-way type of reinforcement, while the Niagara Falls building is of the two-way type.

The Chicago rules give stresses from two to three times those measured in the mid-span for the four-way types, while for the two-way type the Chicago rules agree with the higher measured stress. For the cantilever steel stress over the edge of the capital the Chicago rules result in stresses about 40% above those measured, where no depressed panels are used, and about 100% higher than those measured for the two Chicago buildings having substantial depressed panels.

It has been stated in engineering discussions in this connection by some of the Chicago engineers that tension in the concrete relieves the stress in the steel reinforcement, and accordingly computed stresses should be higher than those measured, in order to allow for this tension effect of the concrete. Probably most engineers will agree that the concrete tension does produce lower measured steel stresses for buildings ridiculously over-designed, like the Larkin Building, where the unit working stresses measured from three to four thousand pounds. These stresses might be about double with the concrete tensile strength not acting. No engineer can put up a very strong argument that the tensile strength of the concrete affects the steel stresses when the latter measure 15,000 to 20,000 lb. per sq.in., and the concrete is broken up by tension cracks of considerable size. Even with low steel stresses of 8000 to 10,000 lb., the concrete loses its tension effect after the load is left on a day or two because under continued stress it gradually stretches out and leaves the steel to sustain the entire tension. This property of the reinforced slab is familiar to those with experience in testing, and can be verified by the outsider who may be unfamiliar with testing, if he will but refer to reports of these tests where he will find cases in which the loading has been left on overnight or for a day or two. These cases show the steel stress materially increased after a day's time, with no increase of loading.

The table shows that the rules required in effect a factor of safety of six for the cantilever portion of the slab, and a factor of safety of eight to ten for the mid-span for four-way systems, and a factor of safety of four for the mid-span of two-way systems. It appears to the writer that this new regulation should be revised to give results more in accordance with the test data, and that until it is revised, one is not justified in claiming that this ruling is based upon test data.

E. S. Martin,
Resident Engineer, C. A. P. Turner.
30 Church St., New York City, Dec. 3, 1914.

Sir—Engineering News, Nov. 12, 1914, p. 993, contains criticisms of the new flat-slab portion of the Chicago Building Code. Some of these objections seem to be due to the fact that your correspondent has given the code insufficient study.

He mentions the "uncertainties" which "should be pointed out," and then proceeds to raise the question of considering the column shaft as part of the resisting section for negative moment over the top of the column. The very definition of "strip A" in the code precludes the suggested interpretation, when it says:

> Strip A shall include the reinforcement and slab in a width extending from the center line of the columns for a distance each side of this center line equal to one-quarter of the panel length.

No mention of including the column shaft or cap in the above definition is to be noted.

The design of flat slabs is admittedly somewhat empirical and the phrase quoted, "At the edge of the column cap or over it," was doubtless inserted to emphasize the necessity of providing within the slab depth sufficient resisting moment from one edge of the column cap to the other. The necessary increase in total resisting moment from the edge of the column cap to the center is provided by the specification covering the size of cap. This increase is assured by requiring that the cap and slab shall be cast monolithic. It, therefore, seems that the only "uncertainty" pointed out is more or less mythical.

The code is further criticized for ignoring the bending in the column shaft. Section 552 limits a reinforced-concrete column in ordinary construction to one-twelfth of its length. The flat-slab code limits the column size to one-twelfth of the panel length. The same section limits in all cases the minimum steel to ½% of the concrete area. The least sizes, therefore, for columns with an average story height of 10 ft. and an average panel of 20 ft., are in the proportion of 20 in. to 10 in., when contrasting flat-slab with any other type of reinforced-concrete floor. For direct load, the flat-slab minimum column is, therefore, four times as strong as the regular column, and for bending eight times as strong, since the column area varies as the square, and the section modulus as the cube of the side of a square column. Thus, this flat-slab code very definitely recognizes and provides for the moments induced in the column shaft, again emphasizing its superiority. Its originators are to be praised for the good judgment shown by inserting this "one-twelfth of the panel length" provision.

Even though the critic's contentions were true for this flat-slab code, the last sentence of paragraph (a), Section 552, of the original code makes it necessary to design columns for the unbalanced moment. The completeness of the flat-slab code, however, prevents any differences of opinion as to the magnitude of the unbalanced moment where small columns would otherwise carry the load.

Your correspondent's demonstration of minimum moment possibilities is delightfully simple. Unfortunately, however, the observed deflections do not conform to the simple assumptions which he has tacitly made. Uniformly increasing bending from his section "MP" to section "NQ" does not obtain, due to the stiffness existing adjacent to the columns by virtue of the bands of steel parallel to "MP" as well as the diagonal bands. Even on so fundamental a proposition as sum total of positive and negative moments per panel, authorities are quite opposed in their views. One extreme, obtained by integration of radial elements, gives a total of about $^1/_7$ WL where W = total panel load and L = distance c. to c. of columns. The other extreme, by demonstrating to the satisfaction of its adherents that "circumferential resilience" equals "radial resilience," gives a total of about $^1/_{19}$ WL. On the same basis, the Chicago Code has $^1/_{30}$ WL negative at column top in each of the two rectangular directions and $^1/_{120}$ WL in each of the two diagonal directions, or a total of $^1/_{12}$ WL negative. Each diagonal band has

$\frac{1}{120}$ *WL* and each rectangular band $\frac{1}{80}$ *WL* or a total of $\frac{1}{24}$ positive moment. The sum for both positive and negative equals $\frac{1}{8}$ *WL*, a commonly accepted total in ordinary construction. These facts seem to indicate that the totals used by the Chicago Code lean decidedly toward the conservative, as is entirely proper in a public regulation. Properly considered, there does not seem to be the element of weakness which the critic fears from his simple demonstration. As for distribution between positive and negative, suffice it to say the coefficients specified by the code accord admirably with the tests upon this type of construction.

Tests, however, upon completed buildings are tabooed. The reason assigned is that "only a portion of the floor is ever loaded." And yet, when discussing moments, emphasis was placed on the fact that the conditions analyzed were those of perfect balance at the columns. One would surmise, therefore, that tests on "portions" would reveal by the extensometer readings, unit stresses far beyond the 25% excess which the critic discovers for ideally balanced conditions. The fact that such excesses do not occur is evidence of the sanity of the code coefficients.

One of the most admirable features of this code is the provision for negative moment in the so called "strips B." Although practically every test shows a tendency for the slab to crack in the top on the rectangular lines between column centers, designers have been altogether too slow about making definite provision for the moments thus indicated. To the writer's knowledge this Chicago Code is the first formal regulation to definitely recognize this weakness in past designs.

It appears, therefore, that its sponsors are to be especially congratulated: (1) Upon the excellent choice of moment coefficients; (2) upon the provision that the minimum column diameter must equal one-twelfth of the panel length; (3) upon the requirement that negative moment must be considered across the top of the rectangular bands.

O. W. Irwin,
Chief Draftsman, Trussed Concrete Steel Co.
Youngstown, Ohio, Nov. 23, 1914.

NOTES AND QUERIES

Data on the life of cast-iron pipe used for discharging sewage are desired by a correspondent in Columbus, Ohio.

G. H. H., Clinton, Mass., writes: "Can you refer me to any souce of information as to the effect of dyehouse acids and steam upon concrete?"

In the article describing the floating caissons for the Panama Canal, by L. A. Mason, in our issue of Dec. 3, due credit should have been given to Henry Goldmark, who was responsible for these structures as Designing Engineer for Lockgates and Protective Devices on the Canal, and to Col. Hodges, Assistant Chief Engineer, who had the primary responsibility for all features of design in connection with the machinery of the locks. During preliminary studies on the lock gates of the canal and their operation, Mr. Goldmark became impressed with the necessity for floating caissons, and advocated their use. After the construction of these caissons was authorized, he was entrusted with the preparation of the plans and specifications for them, and this work was prosecuted under his direction from 1910 until 1913, the final plans being submitted to Col. Hodges, Assistant Chief Engineer. The principal drawings and computations for the caissons were made by Mr. Mason, the author of the article in question, who was an assistant to Mr. Goldmark in the Lockgate Subdivision, a work for which Mr. Mason's long experience in shipbuilding made him particularly valuable. All parts of the design, however, remained under Mr. Goldmark's immediate supervision.

The American Good Roads Congress

The fifth good roads congress of the American Road Builders' Association was held at Chicago last week.

The President, W. A. McLean, Commissioner of Highways for Ontario, in his address pointed out that the use of the term "permanent" as applied to surfacing materials for roads gives the public a wrong impression. Any road surface is subject to wear and disintegration and adequate provision should be made for repair and renewal.

A paper on "Concrete Roads," by J. H. Kuelling, County Highway Commissioner, Milwaukee, Wis., described the extensive construction of such roads in Milwaukee County. The question of expansion joints is unsettled; the spacing has been increased from 25 to 35 ft. and then to 50 ft. without unsatisfactory results. He doubted the necessity of using steel plates in the joints, as these cause the concrete to chip, thus demanding an almost immediate tarring of the joints. A joint with felt filling and slightly rounded edges would meet the requirements. In placing the concrete he preferred a gravity spout to a dump bucket on a boom.

In the discussion, P. C. McArdle, Acting State Highway Engineer of Illinois, advocated thorough rolling, rather than relying upon the concrete to bridge over soft spots. He did not approve of spouting the concrete as it is apt to be made much too wet, which results in ultimate cracking of the concrete. He agreed that armored expansion joints are not desirable, and stated that in Illinois the joint spacing had been increased from 50 to 75 ft., and now to 100 ft.

In a paper on "Brick Roads and Streets," John Laylin, Division Engineer of the Ohio Highway Department, said that while a concrete base is used as a rule, much brick paving has been laid directly upon a sandy or gravelly soil and has given good service for several years under light or medium traffic.

A paper on "Wood and Granite Block Paving," by William A. Howell, Engineer of Streets and Highways, of Newark, N. J., dealt with the practice in that city. Wood blocks are 4 in. thick, laid on a 1-in. cushion of cement and sand (1:4). An unusual feature is the dipping of the blocks in water before laying them. The practice has been successful.

The blocks were treated with 18 lb. of creosote oil per cubic foot of wood. There was some bleeding of oil upon the street, but sand was sprinkled and the coating scraped off, so that there was little complaint of the oil being tracked into buildings. In the discussion, Geo. W. Tillson (Consulting Engineer to the President of the Borough of Brooklyn) briefly reviewed present practice in wood paving, and spoke of slipperiness as a common defect. This may be provided against by open joints, formed by lug blocks or by strips of lath between the blocks, this latter practice being used in Kansas City.

Features of the granite-block paving at Newark are the use of close joints (which gives a smoother and less noisy surface) and the use of old blocks cut in half and dressed to shape. The city proposes to do this cutting and dressing and then sell the blocks to the contractor. Mr. Tillson favored the close-joint stone paving, and thought that the reduction of noise due to rubber-tired motor vehicles would result in bringing granite-block paving into more general use, in view of its high wearing qualities. Mr.

Durham, Chief Engineer of Highways, Borough of Manhattan, New York City, also favored the close-joint paving, and also the use of a bituminous rather than cement filler, as making a less noisy pavement and making easier the inevitable tearing up and relaying of the pavement.

"Bridge Floors and Paving" was dealt with in a paper by Clifford Older (Bridge Engineer of the Illinois Highway Department). This related to steel bridges on country roads and showed the advisability of continuing the regular road-surface material across the bridge. For old bridges, a good floor consists of 3-in. creosoted plank covered with a bituminous gravel composition.

The subject of "Convict Labor in Road Construction" was presented in a paper by T. J. Ehrhart, State Highway Commissioner of Colorado. The system has been in use in that state for 14 years. No armed guards are employed, each man giving his word not to run away, and in six years less than 1% of these men have attempted to escape. About 300 men are now employed in this way.

The exhibition of road machinery, appliances and materials was notably complete and comprehensive.

A Batch Timing and Measuring Device on a Concrete Mixer

The concrete mixer for road work exhibited by the Koehring Machine Co., at the show accompanying the annual convention of the American Road Builders' Association at Chicago last week, has as auxiliary equipment a new attachment for recording the number of batches and for determining the duration of a mix of each batch.

This attachment, called the "Batchometer," consists of a small recording meter and an automatic signal bell, housed with necessary dry batteries in a metal case with glass doors 14 in. square by 4 in. thick. This case is shown in the accompanying view.

When the side loader is raised the short arm shown is also raised, operating the meter and at the same time raising the rod piston in the cylinder, which is filled with glycerin. After a definite time, which can be adjusted as required by a little contact point fastened by a set-screw to the vertical rod and has a range of from 3 sec. to 3 min., the bell is rung as a signal to the operator to dump the batch. The same signal can be used to control the operation of the side loader so that loading and dumping can be made practically simultaneous. Such an equipment eliminates guesswork from the time of batch mixing and should assure the uniform mixing of all the batches. At the end of the day there is also readily available a complete record of the total number of batches run.

OPERATING PARTS OF THE "BATCHOMETER"

Notes from Engineering Schools

UNIVERSITY OF ILLINOIS—The cornerstone of the new Laboratory of Chemistry has recently been laid. This will be a five-story structure occupying a ground area a little over 200 ft. square. It is aimed to make this one of the most complete institutions of the kind in the world and one well adapted for the complete training of men in every branch of chemical work. There are now 1500 students in this department and 54 instructors.

NEWS NOTES

An Ore Wharf and Warehouses Burned at Skagway, Alaska, on the night of Dec. 12. The damage is estimated at $210,000—$60,000 on the wharf, and the remainder on the buildings and contents. A fireboat saved the ore bunkers. This wharf handled all shipping at Skagway.

A Heavy Blast Sent Eight Boulders into a House 200 yd. distant, in Philadelphia, on Dec. 15. The blasting was done by a contractor, and it is not known how heavy a charge he used. The City of Philadelphia limits dynamite charges to 5 lb. The Bureau of Highways is investigating the cause of the accident. The damaged house was a three-story stone dwelling.

A Universal Water-Meter System for Sheboygan, Wis., is proposed and a popular vote on the subject will be taken in April, 1915.

A Road Congress at San Francisco in 1915 will probably be conducted jointly by the American Highway Association and the American Road Builders' Association. Each association is to appoint a committee of two, and the four thus appointed are to choose a fifth member, thus forming an executive committee of five to conduct the congress.

"Car Full" and "Limited Stop" Signs are being displayed on street cars making runs from Boston to suburban points. The "car full" sign is shown at the discretion of the inspectors, and while shown the cars stop to drop passengers, but will take on no more. The "limited stop" sign is used during the evening rush hours, and cars carrying them do not stop to leave passengers until reaching a point some distance out, but stop to take passengers on before reaching that point.

An Architectural Competition for the Australian Parliament House, on the site of the new federal capital of Australia, has been announced. Designs must be delivered in London or in Australia by Mar. 31, 1915. Prizes totaling £6000 are offered, the first prize being £2000. The judges are: George T. Poole, of Australia; John James Burnet, of London and Glasgow; Victor Laloux, of Paris; Otto Wagner, of Vienna; Louis H. Sullivan, an American architect, with offices in the Auditorium Tower, Chicago, Ill.

Reconsideration of the Passaic Gas Case is now pending. About a year ago the New Jersey Board of Public Utility Commissioners reduced the price of gas in the Passaic-Paterson district to 90c. ("Engineering News," Jan. 23, 1913), but the Public Service Gas Co. appealed. The State Supreme Court sustained the commission some months ago, but the highest court (Errors and Appeals) recently reversed the decision. The vote was 6 to 4, and the petitioning communities desire a decision by the full court. Petitions for reargument will be received Jan. 7 and 14.

The City Manager Plan will be voted on at Los Angeles, Calif., on Dec. 31, as a part of a charter amendment which also provides for a city council composed of a mayor and eight other members, all elected at large. The manager would be appointed by the council and would in turn appoint ten department directors, as follows: Public works, public service, harbor, library, health, public utilities, playground, park, fire, and finance. There would also be a city clerk department, under the manager, but the clerk would be nominated by the mayor and confirmed by a majority of the council. The mayor would also nominate and the council affirm a city prosecutor, city treasurer, two police commissioners, five civil service commissioners and nine art commissioners. The people would elect (besides the mayor and councilman) an attorney, auditor, assessor and seven members of a board of education.

An Anti-Civil-Service Policy has been adopted by the West Chicago Parks Commission in restricting employment to residents of the park district. This commission has control of the parks on the West Side. Its argument is that the parks are for the people of that district and that competent employees can be found in its population. Representatives of several civic organizations have appeared before the Commission to protest against this as contrary to the civil-service principle and adverse to the interests of the city as a whole. It was pointed out that, even if this restriction should be applied to ordinary labor positions, it should not be applied in regard to administrative and technical positions, as it would tend to exclude men of competence and special training.

The Bloor St. Viaduct at Toronto, Ont., is to be built of steel, as was noted in our Construction News section of Dec. 17. The contract for the Don section has been let to Quinlan & Robertson for $947,076.01. This viaduct has been the subject of considerable controversy. An effort was made to have it designed in concrete, but the city authorities would not accede to this demand, and made an official design comprising two sections of steel arch viaduct. They, however, permitted alternative concrete designs to be submitted. For the Don section 10 designs were submitted, five of which were on the official steel design and five on special concrete designs made by the bidders. The steel bids varied from $996,500 to $1,353,000 for the steel bridge with the lower deck completed, and from $849,000 to $1,250,000 for the concrete bridge of the same general nature. The accepted bid of $947,076 was for a steel bridge with the lower deck to be completed in the future. The bidder had the low bid also, that is, $996,500, for the steel bridge with a lower deck completed. The Works Commissioner, R. C. Harris, stated in presenting the bid that none of the concrete designs fully complied with the requirements laid down in the advertisement.

Rebuilding the Edison Plant at West Orange, N. J., after the destructive fire of Dec. 9 ("Engineering News," Dec. 17, 1914) is proceeding as rapidly as possible. T. L. Condron, M. Am. Soc. C. E., of Chicago, has been retained by Thomas A. Edison as consulting engineer in the reconstruction work. The first step toward rebuilding was the leasing of two complete cement-gun outfits from the Cement Gun Co., of New York City. It is the intention to use these machines in repairing the damaged columns and girders, though the precise methods of repair have not been fully decided upon. Steel window sash with wire-glass are already being installed in some of the burned-out buildings. The phonograph record building is being inclosed with these windows, and the job will be finished in about two weeks, comprising some 125 windows 12x8½ ft.. Remarkably rapid work is reported in this connection. The order for the sash was received by the Trussed Concrete Steel Co. on Dec. 12; regular factory-type "United" sash, with lights 12x23 in., three swing sections per bay, were called for. Six days later, on Dec. 18, the first lot of sash was shipped from Youngstown, Ohio, by express, and was delivered the following morning, so that some sash were already erected by noon Dec. 19. By Dec. 22 nearly 40 openings had been fitted with sash, and the erection will be completed soon after Jan. 1. The glazing will be Syenite wire-glass. The American Concrete Institute has appointed a special committee to investigate the behavior of the concrete buildings in the Edison plant. The committee consists of Cass Gilbert, the well known architect, chairman; E. J. Moore, of the Turner Construction Co., New York, secretary; Walter Cook, architect; J. Max Taylor, architect; R. P. Miller, of the New York building department; W. H. Ham, engineer, of Boston; Prof. Charles L. Norton, of the Massachusetts Institute of Technology; Richard L. Humphrey, consulting engineer, of Philadelphia, Penn.

Changes in Sewage-Treatment and Pumping, Columbus, Ohio—Acting under orders from the State Board of Health to stop discharging sludge into the Scioto River, plans are being prepared for two-story or Imhoff tanks, and for sludge-drying beds. For the past two years sludge has been discharged into a gravel pit, but the sludge is flooded at high water. It is expected that the new tanks will give so much better sedimentation than the present ones that no changes or enlargements in the dosing chambers and sprinkling filters will be necessary—at least not until they have been well tried with the improved effluent. Money for the proposed improvements has not yet been appropriated, but it is expected that the council will authorize bonds after the plans have been approved by the State Board of Health. The general design for the new tanks was made by Clarence B. Hoover, Chemist and Superintendent of the Sewage Purification Works and Pumping Station, and the construction details are being worked out by J. J. Morgan, Commercial Building, Columbus, Ohio. The Columbus Sewage Works were shut down on Nov. 15 for the balance of this year, on account of lack of city funds to run this and some other city departments.

The sewage pumping station is being remodeled. Under a contract let early in November to Dravo & Doyle, Pittsburgh, the old steam pumps will be replaced by three motor-driven centrifugal pumps of 15,000,000-, 10,000,000- and 5,000,000-gal. capacity, working under a 40-ft. head. Current to drive the pumps will be bought from the municipal lighting plant at 1½, 1¼ and 1c. per kw.-hr. for each successive 25,000 kw.-hr. and ¾c. for all above that, bringing the average price slightly under 1c.

A Coöperative Agreement has been made by the California Water Commission and the U. S. Secretary of Agriculture, to facilitate approval of applications for water rights and occupancy of forest-reserve lands in the development of power. Whenever application for permit for a water-power site is filed with the U. S. District Forester, in San Francisco, notification will be given the commission. When permit to appropriate water is sought from the commission, and use of the water involves occupancy of forest-reserve lands, the U. S. District Forester will be notified and such permit not issued until a complete application for use of the U. S. forest lands has been filed. The commission will defer final approval of such a permit until the District Forester advises that final application for occupancy has been filed or a preliminary application granted with rights to do construction work. The District Forester will confer with the commission before arranging terms of a preliminary permit and file copies of permits as issued. Preliminary occupation permits will allow construction work only in emergency or to comply with state law, and then only upon approval of the commission. Final permits for a site will be issued by the Forester only after the commission has approved the appropriation of water or disclaimed jurisdiction. If the times between beginning and completion of construction, provided in a state water-appropriation and a federal site-occupation permit, are different this will not affect, under state law, the permittee's liability or the cancellation of water right. Loss of state water right, through failure to begin construction, will be sufficient cause for revocation of federal site permit. If either the District Forester or the commission shall fail, within 60 days, to notify the other of action contemplated above, then the one reporting may act without securing notice.

PERSONALS

Mr. Herman Watson has resigned as Superintendent of the Water-Works of Kalamazoo, Mich.

Mr. Heinrick J. Freyn, M. Am. Soc. M. E., has resigned as Third Vice-President of H. Koppers Co., Chicago, Ill.

Mr. William W. Marr, M. Am. Soc. C. E., Consulting Engineer, of Chicago, has been appointed State Highway Engineer of Illinois, to succeed Mr. A. N. Johnson, M. Am. Soc. C. E., who resigned some months ago.

Mr. E. A. Humphrey, Assistant Electrical Engineer of the Great Northern Ry., has been promoted to be Electrical Engineer, succeeding Mr. C. L. Daugherty, recently appointed Assistant General Manager of the St. Petersburg (Fla.) Light & Power Co.

Mr. Layton F. Smith, M. Am. Soc. C. E., Engineer-Architect, Baltimore, Md., has been appointed representative of the city of Baltimore and the Merchants' and Manufacturers' Association, of Baltimore, on the "Link the Americas" cruise, which has in view the bringing into closer contact the business people of South America and the United States. This cruise will leave New York, Jan. 29, and return to that city May 11, 1915. The cruise will entirely encircle the continent of South America, and stops will be made at all the important cities on both coasts. Return will be made through the Panama Canal.

OBITUARY

Walter S. McKinnon, a civil engineer, of York, Penn., died Dec. 18, at the Washington County Hospital, Hagerstown, Md., aged 43 years.

C. T. Tsai, Associate Director of the Pekin-Kalgan Ry., of Canton, China, who was sent to this country by the government of China to study railway management, died Dec. 13, at Asheville, N. C., after an illness of two months.

James A. Baylis, Assoc. Am. Inst. E. E., Engineer of the Bell Telephone Co. of Canada., Ltd., died at his home in Montreal, Que., Dec. 7, from pneumonia. He was born in Montreal in 1869. He graduated from the Worcester Polytechnic Institute in mechanical engineering in 1889 and in electrical engineering in 1890. The same year he joined the staff of the Bell Telephone Co., at Toronto, Ont. In 1895 he went to Montreal as engineer.

William H. Jackson, formerly a civil engineer of note and in his later years an amateur artist of some fame, died on Dec. 15 at his home in Boston, Mass., at the age of 81 years. He was born in Watertown, Mass., and before the Civil War was employed as an engineer by the City of Boston. He served in the 13th Massachusetts Volunteer Infantry as a Captain throughout the Civil War, and subsequently carried on a private practice as a civil engineer, having his office in the Niles Building, Boston. Capt. Jackson spent the later years of his life in painting, and although self-taught, he was considered an artist of considerable ability. He was a member of the Boston Art Club.

Henry S. Hayward, M. Am. Soc. M. E., Consulting Engineer of Floating Equipment of the Pennsylvania R.R., New York City, died Dec. 14, at Augusta, Ga., aged 70 years. He entered the mechanical department of the Pennsylvania R.R. in 1873 as a machinist and draftsman. For many years he was Assistant Superintendent and later Superintendent of Motive Power of the United R.R. of New Jersey. In 1912 he had been Consulting Engineer of Floating Equipment of the Pennsylvania R.R. with headquarters in New York City. He was a charter member of the American Society of Mechanical Engineers. He is survived by a son, Henry S. Hayward, Jr., M. Am. Soc. M. E., Consulting Engineer, 30 Church St., New York City.

J. J. Conway, formerly a prominent civil engineer of Mississippi and for many years a member of the engineering staff of the Illinois Central R.R., died Dec. 5, at his home in New Orleans, La., aged 87 years. He was born in Ireland in 1827 and was educated there as a civil engineer. Soon after his graduation he came to this country and engaged in railway construction in New York State. He then went to Louisiana, where for a time he was with the state engineering department, subsequently going into railway work, becoming Chief Engineer of various lines which came to be parts of the Illinois Central R.R. At the outbreak of the Civil War Mr. Conway joined the Confederate Army as Captain of Engineers and served in the defense of Vicksburg, Miss. After the war he rejoined the engineering staff of the Illinois Central R.R. He resigned about 20 years ago, and had since made his home with his daughter in New Orleans.

Col. Edward D. Meier, Past-President, Am. Soc. M. E., whose death was briefly noted in our obituary column of last week, was born in St. Louis, Mo., 73 years ago. He graduated at Washington University in 1858, and afterward spent four years at the Royal Polytechnic College in Hannover, Germany. During the Civil War he served in the Union Army, and at its close entered the service of the Rogers Locomotive Works at Paterson, N. J. Subsequently he was Superintendent of Machinery of the Kansas Pacific Ry., and Chief Engineer of the Illinois Patent Coke Co. For two years he was Secretary and Construction Engineer of the Meier Iron Co., and in 1884 organized the Heine Safety Boiler Co., of New York, of which he was President and Chief Engineer to the time of his death. He was largely influential in introducing the Diesel engine into this country. He was a Past-President of the American Boiler Manufacturers' Association and was one of the founders of the Machinery Club, of New York City. He was elected President of the American Society of Mechanical Engineers in 1911. A biography and portrait of Col. Meier was published in "Engineering News" of Feb. 2, 1911, soon after his election. Col. Meier was an Honorary Member and Past-President of the Engineers' Club of St. Louis, and in his honor a memorial service was held at the Church of the Unity, St. Louis, Dec. 21.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 28-30. Annual meeting at Chicago, Ill. Secy., F. A. White, Madison, Wis.

SOCIETY OF CONSTRUCTORS OF FEDERAL BUILDINGS.
Jan. 4-6. Convention at Washington, D. C. Secy., T. I. Maul, 4213 Westminster Ave., Philadelphia, Penn.

ASSOCIATION OF GOVERNMENT CONTRACTORS.
Jan. 4-7. Annual meeting at Washington, D. C. Secy., Algernon Blair, Montgomery, Ala.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 15. Annual meeting at New York City. Secy., J. I. Wemlinger, 11 Broadway, New York City.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 19-21. Convention at Chicago, Ill. Secy., F. J. Angier, Mt. Royal Station, B. & O. R.R., Baltimore, Md.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 20-21. Annual meeting in New York. Secy., Charles Warren Hunt, 220 W. 57th St., New York City.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS.
Jan. 20-22. Annual meeting at New York City. Secy., J. J. Blackmore, 29 W. 39th St., New York City.

INDIANA ENGINEERING SOCIETY.
Jan. 21-23. Annual meeting at Indianapolis. Secy., Charles Brossmann, 1616 Merchants Bank Building, Indianapolis, Ind.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
January 27-29. Annual meeting at Springfield, Ill. Secy., E. E. R. Tratman, 1144 Monadnock Block, Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 9-12. Convention at Chicago, Ill. Secy., E. E. Krauss, Harrison Bldg., Philadelphia, Penn.

AMERICAN CONCRETE PIPE ASSOCIATION.
Feb. 15-16. Annual convention at Chicago. Secy., E. S. Hanson, 538 South Clark St., Chicago, Ill.

Association of Highway Commissioners of the United States—This Association was organized at a recent meeting in Atlanta of the American Road Congress. Its first meeting was held on Dec. 12, for the purpose of electing officers and of discussing Federal highway legislation, to be taken up by Congress during the present session.

Montana Institute of Municipal Engineers—The third annual meeting of the Institute will be held at Helena, Mont., Jan. 18-20. Among the papers to be presented are the following: "Publicity and the City Engineer," by Henry Gerharz; "Objects and Use of Testing Bitumens for Paving," Wm. B. Vestal, Jr.; "Present Status of the Pollution of Waterways in Montana," Prof. Wm. M. Cobleigh; "The Experimental Sewage Plant in Bozeman," Carl C. Widener. The Secretary is Carl C. Widener, Bozeman, Mont.

San Francisco Association of Members of the American Society of Civil Engineers—At the 57th regular meeting of the Association, the address of the evening was given by Prof. E. Derleth, Jr., on the "Sather Tower at the University of California," Berkeley, Calif. The speaker exhibited stereopticon views of various campaniles and other slender towers of Europe and America, commenting on their individual characteristics. He followed with plans and erection views of the Sather Tower, and a general discussion of the problem of providing for stresses due to the vibration arising from earthquake shocks. The tower is a steel-frame structure, fireproofed with concrete and faced with granite, 303 ft. above ground and 28 ft. below, with a base 33 ft. 9 in. square, tapering to 30 ft. 6 in. square at a height of 189 ft. 6 in. above the ground. This section continues to an elevation of 234 ft. 2 in. above ground, where the crowning pyramid begins. There are 10 floors above the ground, designed for a live load of 60 lb. per sq.ft., with stairways throughout and elevator to seventh floor. The frame is carried on 16 columns anchored to a grillage foundation, which is supported on a reinforced-concrete foundation slab 48 ft. sqare and 45 in. thick. Only the four corner columns are carried above the eighth floor to the tenth floor, where trusses carry the pyramidal structure above. Diagonal and cross-bracing is provided in alternate vertical bents only, beginning with the foundation bent below ground; the purpose being to provide requisite flexibility against earthquake shock through the unbraced panels. Wind pressure was assumed at 20 lb. per sq.ft. The regular annual meeting of the Association was held at 6 p.m., Dec. 18, when a dinner was served. Later, J. G. Galloway spoke on "The Installation of Unit No. 5 at the Las Plumas Power Station of the Great Western Power Co." He described the design and construction of a 10,000-kw. generator and an 18,500-hp. turbine, 60-in. hydraulically operated gate valve, a 72-ft. penstock, with pressure oil systems, etc. The Secretary is E. T. Thurston, Jr., Room 713, Mechanics' Institute, San Francisco, Calif.

Engineering Literature

CONTENTS

	Page
CORRESPONDENCE:	
A Card-Index Multiplication Table. F. C. Williams.	1281
REVIEWS AND NOTES:	
High-Power Gas Engines. Reviewed by H. E. Longwell	1281
Strength of Materials. Reviewed by Lewis E. Moore.	1282
Plane Surveying for Use in the Classroom and Field.	1282
The Express Service and Rates	1283
A Popular Treatise on the Colloids in the Industrial Arts	1283
Mechanism of Steam Engines. Reviewed by Winslow H. Herschel	1283
Factory Administration and Accounts. Reviewed by Rossiter R. Potter	1284
Graphic Methods for Presenting Facts	1284
Unit Construction Costs	1284
Handbook of Construction Plant	1285
Rural Improvement	1285
Surveying Manual	1285
Examination of Lubricating Oils	1286
The Cleaning of Blast-Furnace Gases	1286
Taschenbuch für Bauingenieure. Reviewed by Leon S. Moisseiff	1286
Iron Ores—The Deposits of the Useful Minerals and Rocks	1287
Geological and Topographical Maps, Their Interpretation and Use	1287
PUBLICATIONS RECEIVED	1287

CORRESPONDENCE

A Card-Index Multiplication Table

Sir—In your editorial remarks on my letter of Oct. 29, published in your issue of Nov. 19, you say of my card system of multiplication:

> Products up to 9×999 can be read directly. Beyond that simple multiplication followed by addition is required.

I think if you had understood more fully the purpose of the device, you probably would have said:

> Beyond that by a proper manipulation of the cards any two numbers (no matter how large) may be multiplied together by simple addition. Also, the device may be used for performing division by simple subtraction.

F. C. Williams.

Commercial Bank Building,
Cleveland, Ohio, Nov. 24, 1914.

REVIEWS AND NOTES

An English Translation of a German Gas-Engine Book

Reviewed by H. E. Longwell*

HIGH-POWER GAS ENGINES—By H. Dubbel. Translated from the German, and Edited and Expanded so as to Include British Engines and British Practice by F. Weinreb. New York: D. Van Nostrand Co. Cloth; 7x11 in.; pp. xii + 197; 423 illustrations and 13 folding plates. $5, net.

The author has been a frequent and acceptable contributor to the *Zeitschrift des Vereins deutscher Ingenieure*. Inasmuch as he has been able to satisfy the critical editor of that journal, it is more than probable that the book as originally written was a reasonably good one. One cannot conscientiously say as much of the translation. Evidently, it has suffered considerably at the hands of the translator who claims to have "edited and expanded" it. Notwithstanding the translator's expressed obligations to the gentleman "who read and corrected the first English version of the manuscript in a most thorough manner," the style is so obscure and the punctuation so bad that in many places the text is unintelligible.

The work is copiously illustrated with detail drawings and diagrams, most of which have appeared on a larger scale in sundry European technical journals during the past twelve or fourteen years. These illustrations, in connection with the generous size of the pages, and the excellent quality of the typographical work, give the volume an attractive appearance that makes the worse than mediocre quality of the text all the more noticeable.

We are advised, on p. 18, that "the thermal efficiency is found from the heat consumption in the B.t.u. per i.hp. per hour *for which the usual value is from 478 to 504 B.t.u. per i.hp. per hour*" (italics mine). To engineers who have been laboring under the impression that the heat consumption of an engine of 100% efficiency is not less than 2545 B.t.u. per hr., these figures indicating efficiencies of over 500% will be a trifle startling. The probable explanation is that in translating calories into British thermal units the ratio, approximately 3.96, has been used as a divisor instead of a multiplier.

We find in detail, p. 85, the calculations for determining the size of the air and gas pumps for a two-cycle gas engine of 800 b.hp. The result of the calculations indicates that *the displacement of the gas pump should be somewhat greater than that of the working cylinder.* This on its face is, of course, ridiculous. A critical examination of the calculations shows that the displacement of the air pump was first determined, and the displacement of the gas pump was fixed by multiplying the displacement of the air pump by the ratio of gas to air in the working mixture. The trifling incident of some 40% of the air being used for scavenging purposes, and not requiring to be mixed with gas, seems to have been overlooked.

These examples will suffice to indicate the inexcusable carelessness displayed in the preparation of the work.

As an illustration of the effectiveness with which words may be used to conceal an idea, the following quotation, p. 34, is submitted:

> When quantity governing is adopted, the mixing valve may close at no load at the beginning of the suction stroke, and at full load at the end of the suction stroke. The time available for governing will then last up to the time of ignition during a crank travel of 180° to 360°. If the governing is effected by throttling, the time available for governing will only last during 180° before the ignition point, and the governor therefore has to act quicker.

Most engineers imagine that governing by throttling *is* quantity governing; and they will wonder why the

*Consulting Engineer, Westinghouse Machine Co., East Pittsburgh, Penn.

governor can act only during that part of the revolution in which there is no inflow of fluid to be acted upon.

Speaking of the action of the governor on the inlet valve-gear of blowing engines the author says, p. 34:

> With quantity governing the gas valve remains open during the whole suction stroke, and therefore gas enters the cylinders 15 seconds during each minute, quite independently of the number of revolutions per minute, one suction stroke taking place every four strokes.
>
> The amount of gas entering the cylinder per minute when the speed is reduced therefore remains the same as at the higher speed if the inlet area remains constant, as the gas is supplied above atmospheric pressure.

Note the second paragraph!

Evidently the author is not familiar with the common expedient of using a regulating apparatus in the supply line to maintain the gas pressure constant and substantially equal to that of the atmosphere.

Even the descriptions of the illustrations are not free from error. In describing the cylinder construction of a well known American engine, p. 112, it is stated that "the internal cylinder and external jacket are cast together." Anyone with reasonably good eyesight can see, from a casual inspection of the drawing, that the jacket is a separate casting.

In Chapter XI, on Stuffing-boxes, we are gravely informed that "when arranged in a vertical direction the packing can be adapted to the rod," which doubtless will be a comforting assurance to the designer of gas engines.

In Chapter XIV, on Starting, we have the following:

> Fig. 372 shows a compressed air starter (Krupp). The piston valve admitting the compressed air is moved by a hand lever.
>
> When compressed air is used for starting it is generally delivered by an independent auxiliary air compressor, and stored up in receivers at a pressure of from 145 to 300 lb. per sq.in. These receivers have to be provided with water drainage to prevent condensation on the ignition plugs.

When the reader turns to Fig. 372, and sees that it illustrates a simple compressed-air motor acting on the flywheel and exhausting into the atmosphere, he is naturally at a loss to understand how the compressed-air supply can have any effect on the ignition plugs.

As will be gleaned from the foregoing extracts the quality of the book—or rather its lack of quality—is such that a detailed outline of its contents and general plan would not be of much interest.

To sum up briefly, the book contains a large number of reproductions of sectional and detail drawings of large gas engines, illustrative of good, bad and indifferent practice. The drawings are not new, but have been collected from widely scattered sources, and there may be some engineers and designers who will be glad to have them conveniently compiled in a single volume.

The text will not hurt the novice, as it will bewilder him so completely that he will not persevere very long in his efforts to read it. Its effect on the experienced engineer will be either amusing or irritating, depending on whether or not he is endowed with a sense of humor.

⌘

THERMAL PROPERTIES OF STEAM—By G. A. Goodenough. Bulletin 75, Engineering Experiment Station. Urbana, Ill.: University of Illinois. Paper; 6x9 in.; pp. 69; illustrated. 35c.

The author of this bulletin has developed a "general theory" of the properties of saturated and superheated steam based on the more accurate experimental evidence that has accumulated since the classic researches of Regnault (1847). This "theory" covers the (1) deduction of fundamental equations for heat contents, specific heats, latent heats, entropy, etc., which take into account fundamental thermodynamic relations; (2) checking constant to agree with the most reliable data; and (3) arranging equations in simple form and so that modifications to compensate for new data will make slight changes.

⌘

A New Edition of Murdock's "Strength of Materials"

REVIEWED BY LEWIS E. MOORE*

STRENGTH OF MATERIALS—By H. E. Murdock, Irrigation Engineer, United States Department of Agriculture. Second edition, revised and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xv. + 352; 137 illustrations. $2, net.

The first edition of this book was reviewed in these columns on Jan. 18, 1912. The new edition is virtually identical with the old, with two added chapters on reinforced-concrete beams and columns.

The chapter on reinforced-concrete beams is clearly written and the author very carefully points out the assumptions made, and indicates plainly that reinforced-concrete design is by no means mathematically exact. The most generally accepted theories are developed and explained lucidly, although the common assumption that the resultant of the compression stresses in a T-beam acts at the mid depth of the slab is not mentioned.

The chapter on reinforced-concrete columns is little more than a résumé of the generally accepted principles of design for such members. The author wisely does not attempt to deduce any mathematically exact formulas for columns of this class.

⌘

PLANE SURVEYING For Use in the Classroom and Field—By William G. Raymond, M. Am. Soc. C. E., Dean of the College of Applied Science, State University of Iowa. Second edition. New York and Chicago: American Book Co. Flexible leather; 5x7 in.; pp. 589; 239 illustrations. $3.

The original edition of Prof. Raymond's book was reviewed in these columns, Dec. 31, 1896. Until now the book has undergone no changes. In revising the book the author seems to have kept the original method and style throughout, although some additions and changes have been made in the text.

In reviewing the original edition we commended the book for the fullness and clearness of its text, and although many books on surveying have since appeared, this may still be said to rank among the first in those desirable qualities. It is designed as an elementary textbook and therefore leaves much to be said on many phases of surveying work, but as an elementary textbook it covers clearly and concisely the principles of the theory and practice of surveying.

The new edition is printed in pocket size with flexible binding and apparently answers the purpose of both a classroom textbook and a field pocket-book, which instructors in surveying now appear to consider an essential feature of a course in surveying.

⌘

A third edition of "Lehrtwet der Meteorologie," by Dr. Julius Hann (University of Vienna), with the coöperation of Doctor Süring (Potsdam), has been published by Chr. Herm. Tauchnitz, of Leipzig, except that the last of the ten parts into which the treatise is divided appears to have been delayed by the European war. The nine parts

*Engineer of Bridges and Signals, Massachusetts Public Service Commission, 1 Beacon St., Boston, Mass.

already issued extend to 800 pages. The revised work is characterized by Prof. R. DeC. Ward (Howard University), in *Science* of Nov. 27, "as the master-work on the science of the earth's atmosphere."

Express Company Service

THE EXPRESS SERVICE AND RATES—By W. H. Chandler, Assistant Manager, Traffic Bureau, The Merchants' Association of New York. Chicago: LaSalle Extension University. Cloth; 6x9 in.; pp. v + 340. $3.

The intricacies of the transportation system comprised by the services of the many express companies in this country were once a complicated puzzle to which few, if any, had the keys before these independent and secondary agents were specifically put under federal regulation on the same basis as the railroads. The several reports of the Interstate Commerce Commission have opened up the situation marvelously and made possible still further study by such interested students as the author of this work.

Mr. Chandler's treatise is a part of a home-study course in interstate commerce and railway traffic. The first part of the work covers the early history of the express industry, its organization, capitalization, earnings, internal organization, character of service rendered, relations with railroads, etc. Unfortunately, this was written before the recent liquidation of the United States Express Co. and the consequent transfer of its routes to other concerns.

It is known in a general way that the entire express service of the country has been radically changed since the Interstate Commerce Commission was given control. How this has come about and what it now means is well approached by a short review of the common-law attitude, the various state attempts to regulate the business, the powers of the Interstate Commerce Commission and the practices that needed its attention. Then follows the new rate system, prescribed by the Commission and in force for at least two years.

Chapters follow on the special services of the express companies—money order and financial, order and commission and foreign. Finally, there is a brief exposition of the undeveloped electric-road express, the influence of the parcel-post competition (which the author shows is not so fundamentally serious as imagined and may decline once the novelty has worn off), and of Canadian tariffs.

A POPULAR TREATISE ON THE COLLOIDS IN THE INDUSTRIAL ARTS—By Prof. Dr. Kurt Arndt, Private-Dozent at the Technische Hochschule, Berlin, Germany. Translated from the second enlarged German edition by Nahum E. Katz, Chemist to the Eagle Cotton Oil Co., Meridian, Miss. Easton, Penn.: The Chemical Publishing Co. London, England: Williams & Norgate. Cloth; 5x7 in.; pp. 72. 75c.

In as nontechnical language as could be expected without going to an extreme, the author presents, as he says in his Preface he aims to do, *"a Vivid Picture of the Great Significance* which the Colloids have in numerous important practices." The book is all the more interesting because the knowledge of colloids is so new, the word itself having been "first used by Th. Graham half a century ago to denote various substances which, indeed, chemically, have nothing to do with glue, but which resemble in appearance the soaked-up cabinet-maker's glue."

Besides colloids in the hydraulic-cement industry, in sewage purification, lubricating grease, varnishes and soap, the author tells about their relation to ruby and other glasses, silver and gold mirrors, ceramics, tungsten lamps and a variety of other things.

The book can be read in an hour and bids fair to amuse and instruct many who have noted the increasing use of the word colloids in various technical discussions, but who have felt that the subject was beyond the ken of ordinary mortals—if, indeed, it was really understood by anyone.

A New Book on Steam Engines

REVIEWED BY WINSLOW H. HERSCHEL*

MECHANISM OF STEAM ENGINES—By Walter H. James, Assistant Professor in the Department of Mechanical Engineering, and Myron W. Dole, Instructor in Mechanical Engineering, Massachusetts Institute of Technology. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. viii + 170; 183 illustrations. $2, net.

Until some other form of prime mover is developed which can be started, stopped and reversed with the speed and facility of a steam engine, this old and reliable servant of man will continue to be a suitable subject of instruction for each succeeding generation of students. The steam-engine designer must be acquainted with the relative motion of parts, or kinematics, the action of the working fluid and the strength of parts to resist the forces to which they are subjected. The elementary treatise of James and Dole deals mainly with the kinematics of the problem, though indicator cards and valve diagrams are treated briefly so as to make the whole subject clearer to a student whose previous knowledge was derived from casual references to steam engines in a book on the elements of mechanism. The book might well be called "Valves and Valve-Gear Mechanisms." One chapter is devoted to typical problems of the slide-valve engine, but otherwise no problems are given. In a subject requiring graphical solutions, a student may sit and study almost indefinitely without any certain knowledge as to whether or not he understands what he reads. But let him try to solve some problem and he will soon realize whether he can find the answer. It is therefore most desirable that a book on valve-gears should be well supplied with problems. The last two chapters are devoted to the mechanisms of steam turbines, a subject not usually found in a book on valve-gears. While keeping within a small compass, the book explains, with a minimum amount of mathematics, all the kinds of steam-engine mechanisms that would be usually met with. It is to be regretted, however, that the authors have not fulfilled the promise of the introduction to deal with the kinematics of other machines, such as pumps and compressors, since this is a much neglected subject about which very few elementary textbooks are available.

An interesting report of ten printed foolscap pages on "Investigations of Land Settlement and Irrigation Development in America" was made under date of June 29, 1914, to the Minister of Water Supply of Victoria, Australia, by Elwood Mead, Chairman State Rivers and Water Supply Commission (Treasury Gardens, Melbourne, Victoria, Australia). The report is based on a recent visit by Mr. Mead to the United States and Canada. It outlines irrigation conditions in Victoria, as well as in North America, and deals with some problems common to both continents. The "closer settlement" pol-

*Assistant Physicist, Bureau of Standards, Washington, D. C.

icy and practice of Victoria, with its loans to settlers, is approved by Mr. Mead. The financial troubles of American irrigation development are commented on, and are summarized as follows:

(1) Construction of works outran the demand for irrigation by those able to pay for it.

(2) Failure to extend aid to men of small capital in overcoming initial obstacles.

The report concludes with some agricultural and horticultural notes, based mostly on observations in California.

British Methods of Factory Management

REVIEWED BY ROSSITER R. POTTER*

FACTORY ADMINISTRATION AND ACCOUNTS: A Book of Reference with Tables and Specimen Forms, for Managers, Engineers and Accountants—By Edward T. Elbourne, Department Works Manager to the Birmingham Small Arms Co., Ltd. With Contributions on "The General Problem of Industrial Works Design," by Andrew Home-Morton, M. Inst. C. E., of Home-Morton, Ker & Gibson, and "Financial Accounts," by John Maughfling, Secretary to I. Thornycroft & Co., Ltd. New York and London: Longmans, Green & Co. Cloth; 7x10 in.; pp. xv + 638; illustrated. $7.50, net.

It should be mentioned first of all that this is primarily a reference book, a sort of encyclopedia of methods. It is analytical in the extreme, in the sense that it delves deep into the small details of management. For example, a page and a half, mostly in fine print, is devoted to the proper duties of a factory gatekeeper, with a specimen set of gatehouse regulations.

The book is divided into six chapters or sections. The first section (only 25 pages) appears to be the contribution of Andrew Home-Morton and deals with the general problem of industrial works design, including the renovation of old works. In this chapter appears the interesting admission that the subject of factory design along well thought out lines is much better understood in the United States than in Great Britain. Section II takes up General Administration; III, Works Administration; IV, Works Accounts; V presents an exhaustively complete collection of routine forms, and Section VI a definite set of financial accounts for a large manufacturing concern. The forms shown in these last two sections are made to harmonize in a general way with the ideas set forth in the preceding sections.

Sections II and III, on general administration and works administration, cover about the same ground as the various American books on "scientific management." The author's attitude is sane and conservative and he puts things in a way that can be accepted even by those inclined to harshly criticize the more rabid type of efficiency enthusiast. The subject is dealt with here, however, rather more from the viewpoint of the business man than from that of the engineer. Section IV (Works Accounts) covers the same field as American books on cost keeping. The author is in harmony with American writers on this subject in advocating the machine-rate plan as the most nearly exact practical method for apportioning indirect expense, or "shop charges," to use his own term. About 30 pages in this section are devoted to the problem of inventory or stock taking and to the valuation of buildings and equipment.

The book is well arranged to facilitate quick reference to any desired topic, and there is an exceptionally complete index. The table of contents is printed with two columns to the page, one sub-topic to a line. With this arrangement, the contents of a whole chapter can be noted almost at a glance, so that the table becomes of really usable value in supplementing the index. This is a feature that might well be imitated in all technical books. The table of contents of the prevailing style, with subtopics run together in solid paragraphs, is so slow and painful an affair to use that nobody ever thinks of consulting it when looking for anything in a hurry.

The chief use of this book for American readers will be for reference and comparison when establishing new rules and methods or revising printed forms. The differences between British and American conditions, laws, shipping facilities, etc., are of some effect in reducing the book's value. American managers will entirely forget their own comparatively trivial worries while reading of the snarl of red-tape and "system" necessitated by the British national health insurance act, applying to practically all working people between the ages of 16 and 65. All things considered, this book will have to be classed as a luxury rather than a necessity in this hemisphere, but those who can easily afford it to use for reference only will doubtless get their money's worth.

GRAPHIC METHODS FOR PRESENTING FACTS—By Willard C. Brinton. New York: The Engineering Magazine Co. [Works Management Library.] Cloth; 7x10 in.; pp. xii + 371; 256 illustrations. $4.

While figures cannot lie, when marshaled in sufficient number and complication they can often present a pretty fair semblance of deception. For this reason it has long been a practice among statisticians to reduce their figures and facts to a graphic concentration that permits of easy and rapid understanding of the data. It is a part of the engineer's business to be familiar with such graphic presentations but there are many quirks and turns in the statistician's graphical methods with which the engineer rarely comes in contact. Mr. Brinton's book is of value to the engineering profession mainly on this account. To the statistician it probably has greater value, but on that score we are not so competent to judge.

Briefly, the book is a conscientious effort to give all of the various methods of graphic representation. This necessarily includes the ordinary curves and diagrams and the higher cumulative and mass curves, frequency curves, etc., with which the engineer is familiar. In addition it comprises the different photographic and pictorial representations of comparative figures and the various curve forms which are adapted to business enterprises, such things as cost and production records. In addition to being very interesting, the book should make a valuable reference, for from the text an example may be found of any proposed type of graphical representation.

UNIT CONSTRUCTION COSTS From the New Smelter of the Arizona Copper Co., Ltd.—By E. Horton Jones. New York and London: McGraw-Hill Book Co., Inc. (Republished by Special Arrangement with the American Institute of Mining Engineers.) Cloth; 6x9 in.; pp. 1497-1649, illustrated. $2, net.

This is by far the most specialized cost-data book which has ever come to our attention. It is purely and simply a list of cost sheets giving unit-construction costs of the building of the Arizona Copper Co.'s new smelter at Clifton, Ariz. Practically its only value is in the design and construction of a similar plant, though possibly some of the detailed figures may be of use in other types of work.

*Assistant Manager and Production Engineer, Blood Bros. Machine Co., Kalamazoo, Mich.

A Handbook in a New Field

HANDBOOK OF CONSTRUCTION PLANT; Its Cost and Efficiency—By Richard T. Dana, M. Am. Soc. C. E., M. Am. Inst. M. E., Consulting Engineer. Chicago: Myron C. Clark Publishing Co. London: E. & F. N. Spon, Ltd. Flexible leather; 5x8 in.; pp. 702; 312 illustrations. $5.

The vast business of contracting is gradually acquiring a literature, but the process is slow and hard. Mr. Dana's book is, however, quite a forward step in developing that literature. Possibly the most important single thing in a contracting operation is the plant, and the cost of that original plant and the cost of operating it are factors upon which contracting failure or success depends. It has been Mr. Dana's object to reduce to lowest terms such itemized costs. These are presented in this book in alphabetically arranged sections, and the list includes practically every machine or device which can be used in contracting work.

Merely to glance through that list we might name the following headings as an indication of the type of subjects considered: Air Compressors, Asphalt Distributors, Automobiles, Bar Benders, Barges, Blacksmith Batteries, Boots, Cableways, Cameras, Carts, Conveyors, Crowbars, Derricks, Drawing Tables, Dredges, Drill, Explosives, Fuse, Hammers, Hydraulic Giants, Ladders, Log Chains, Mauls, Pile-Drivers, Poles, Pumps, Rails, Roofing, Saws, Scows, Spreaders, Switches, Tarpaulin, Teams, Traction Agents, Unloaders, Wagons, Wheelbarrows. Under each of the headings, of which the above list is only a small part, is given a recent series of prices, a brief description, sometimes with illustrations, of the device, and in most cases some cost data with a brief description of the work on which it is used.

The book is valuable for any one estimating on construction work—provided, of course, that they combine with the figures given in the book a fair knowledge of local conditions and of the business in which they are engaged, so that they may temper the printed words with personal authority. As the author truly says in the preface, no book can tell a contractor automatically what equipment is the best for his use, but it is possible to put him in possession of vastly more information than has heretofore been available, and this has been attempted in the present volume.

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RURAL IMPROVEMENT: The Principles of Civic Art Applied to Rural Conditions, including Village Improvement and the Betterment of the Open Country—By Frank A. Waugh. New York: Orange Judd Co. London: Kegan Paul, Trench, Trübner & Co., Ltd. Cloth; xi + 265; illustrated. $1.25, net.

Professor Waugh gives much sensible advice on how villages and outlying sparsely settled districts may enter more largely into the benefits which come from intelligent city and town planning, modern sanitation and community improvement generally—physical, economic and social.

In the opening pages more is said about civic art and the beautiful than is likely to be relished by some people who read the book, but the doctrine is sound. Elsewhere the author tends to mislead the uninformed to put too much faith in the septic tank as a means of sewage treatment, and to think that macadam roads are not only the ideal to which every community and country-side should look forward but also that they can be built for $3500 to $4000 a mile. These dangers are perhaps more than offset by repeated advice to call in the engineer or other competent professional adviser wherever and whenever problems outside the ordinary are met.

A moderate number of line and halftone engravings, for the most part well chosen, add to the interest and value of a book which deserves wide circulation in the rural districts, villages, and even in many so called cities of the United States and Canada.

⌘

SURVEYING MANUAL: Designed for the Use of First-Year Students in Surveying and Especially for the Use of Non-Civil Engineering Students—By Howard Chapin Ives, Professor of Railroad Engineering, Worcester Polytechnic Institute. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Leather; 4x7 in.; pp. viii + 296; 56 text figures and numerous plates. $2.25, net.

Like many similar texts this "surveying manual" is chiefly in the form of specific instructions to students for performing certain surveying problems. Included are brief descriptions of instruments and discussions of their adjustments, a brief chapter on the elements of railroad curves, one on the United States system of laying out public lands, on computations, on plotting, and a few pages on astronomy. About 100 pages of tables for stadia reduction, logarithms, trigonometric functions, etc., add considerably to the practical value of the book, but even then a book of this type, of which there are a great many, is not sufficiently complete or practical to be of any permanent use to the field engineer.

For students of civil engineering who must ultimately own larger and complete texts on surveying, and books of formulas and tables such as Searles' "Field Engineering," these various elementary surveying manuals seem a little superfluous, although the use of them unquestionably eases the work of the instructor. Surveying is nothing but the application of geometry and trigonometry to the ground under our feet by the use of implements and instruments, and the principles involved are generally very simple and easily understood. Detail instruction for simple problems may be essential with some students, but such instruction is merely a substitute for a very elementary knowledge the student should have before he begins his course in surveying.

Space is given in most of those manuals, and we believe in most engineering schools considerable time is also given, to exercises with the surveyor's chain, which is obsolete so far as real engineering work is concerned. It is very doubtful if the old-time Gunter's chain can be found anywhere nowadays except in the instrument rooms of technical schools, and whatever value the experience in using it may be to the student, just as much good could be had by following the same exercises with a steel tape. The reduction of old-time surveys in chains and links to feet and tenths is much more easily performed on paper than with a chain in the field.

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A history of the American Society of Mechanical Engineers from its organization in 1880 to the present year, has been compiled for the Society by Prof. F. R. Hutton, who, by his 24 years' experience as Secretary of the Society, is best able to write with authority on the subject. The history, which is now ready to go to press, is to be published by subscription, and will be a book of 200 pages, uniform in style with the Society's "Transactions."

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A new periodical, entitled "Structural Conservation," appeared under date of October, 1914, as Vol. I, No. 1. According to its editorial page, its mission is threefold, educational, instructional and discussional, and its main purpose is to educate its readers in the fundamental and underlying principles of waterproofing. The first num-

ber contains an article by A. R. A. Plumb on "Structural Waterproofing and Dampproofing"; another by Myron H. Lewis, on "Waterproofing as a Problem in Conservation," and a third by A. D. Hyman, on "Theoretical and Practical Considerations in the Successful Application of Waterproofing." Other brief articles are not signed. The new periodical is edited by E. G. Frank and is published in Detroit on the 15th of each month, but the publisher is modest; nowhere in the first issue can we find his name or the address of the publication office.

Notes on the Examination of Lubricants

EXAMINATION OF LUBRICATING OILS—By Thos. B. Stillman, Late Professor of Engineering Chemistry in the Stevens Institute of Technology. Easton, Penn.: The Chemical Publishing Co. London: Williams & Norgate. Cloth; 6x9 in.; pp. iv+125; illustrated. $1.25.

Prof. Stillman's comprehensive collection of notes on the laboratory examination of lubricants will be welcome to a wide range of readers, so far reaching is the use of scientifically prepared oil and grease compounds and so difficult is prior assurance that they will prove adapted to the expected service.

The several tests are presented in the following order: Specific gravity, congealing, viscosity, iodine absorption, flash and fire temperatures, acidity, temperature and color action under acid, separation of mineral and vegetable or animal oils, gumming, sulphur content, water content, gasoline solution, microscopic scrutiny, carbon residue, paraffin content, soap content, saponification value, tar content, coefficient of friction, rape-seed and cotton-seed content, cylinder-deposit analysis, scrutiny of petroleum, and the behavior of lubricating oils in saturated and superheated steam, air, carbon dioxide and other gases.

Although the volume is of uncommon value, yet it is to be regretted that there could not have been more care and time spent on the finish of the text, which gives evidence of a hasty assembly of disjointed notes. It is decidedly inconvenient to have various general specifications for miscellaneous oils and greases scattered through the book and attached to one test or another which forms but a part of the specified examination. Thus, some lard-oil specifications are appended to notes on "acid test," and several railroad oil specifications follow "friction tests," though a few follow "cold tests." There are some obvious errors in words and figures which will cause faint doubts in the mind of the inexperienced reader on the complete accuracy of other statements.

THE CLEANING OF BLAST-FURNACE GASES—By Frederick H. Wagner, M. Am. Soc. M. E. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 168; 58 text figures. $2, net.

The aim of the author to place on record, in easily available form, the latest information of cleaning blast-furnace gas is commendable. The book should be interesting to all gas-engine plant designers in showing them the pains that have been taken to secure a clean waste gas from which power may be developed conveniently and economically.

The author first outlines the demand for clean stack gas which came with the use instead of the mere discharge of the gas. Then the theoretical aspects of cooling and condensing moisture burden are presented. The cleaning processes and apparatus are described under three heads: (1) First-stage or dry-dust catchers; (2) second-stage or wet cleaners and coolers; (3) third-stage or final cleaners. The first-stage machines described are the "centrifugals" and the "whirlers." The second-stage equipment covers coke and grid scrubbers, baffle and spray towers, slow rotary washers, high-speed centrifugal washers. The final-stage equipment includes centrifugals, "disintegrators" (combination fan sprays), washers, bag houses, water-coil towers with screens and baffles, and the Cottrell electric-precipitation scheme. Much of the apparatus described is European, so that the author has found it advisable to append a chapter on operative plants in America.

A New Edition of Foerster's Taschenbuch

REVIEWED BY LEON S. MOISSEIFF*

TASCHENBUCH FÜR BAUINGENIEURE — Herausgegeben von Max Foerster, Geh. Hofrat, ord. Professor an der Technischen Hochschule in Dresden. Second edition. In two parts. Berlin: Julius Springer. Cloth; 5x8 in.; pp. xvi + 2078; 3054 text figures. 20 marks.

To attempt the publication of a new civil-engineering "pocket book" in German after the famous "Hütte" had attained its twentieth edition and was expanding into a third volume was a daring act on the part of Prof. Foerster, as well as on that of his publisher. The new book met, however, the demand so well that the first edition was exhausted in three years and a second and an enlarged one has been published.

This civil engineers' pocket book is in 27 divisions, each representing in a condensed form the established knowledge of the treated subject. It covers the entire field of civil engineering and even contains a very substantial treatise on machinery generally used in connection with civil-engineering work and a short one on the principles of law. This wealth of information is condensed on twenty-one hundred pages and illustrated by more than three thousand figures, forming a book which requires a very substantial pocket to contain it. Like most modern works of its kind, it is a result of the cooperative efforts of more than a dozen specialists. With a few exceptions, the book is a product of the Dresden Polytechnic School and in many ways it displays characteristics distinct from the Berlin center of engineering influence.

Engineers familiar with the works of Prof. Mehrtens, the dean of the Dresden Polytechnic School, will be pleased to learn that four hundred pages have been written by him. Prof. Mehrtens deals with the theory of trusses, graphical statics, strength of materials, and the statics of structures. He also covers the field of steel bridges. It is needless to add that the treatment is lucid and practical.

Prof. Foerster, who is well known by his book on steel buildings and his many-volumed treatise on building materials, has chosen for his subjects the theory of reinforced-concrete construction, building materials, and the structural elements of steel buildings. The important subject of hydraulic engineering, exclusive of water-supply and sewerage, is treated by as eminent an authority as Prof. Engels.

Chapters have been added in the new edition on factory building, on special structures of reinforced concrete, such

*Engineer of Design, Department of Bridges, Municipal Building, New York City.

as foundations, bins and reservoirs, and on city planning.

A judicious introduction of numerical examples serves to enhance the usefulness of the book. The book is well gotten up and is a fine example of German efficiency.

Ore Deposits

IRON ORES, Their Occurrence, Valuation and Control—By Edwin C. Eckel, Assoc. M. Am. Soc. C. E. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xvii + 430; 66 illustrations. $4, net.

THE DEPOSITS OF THE USEFUL MINERALS AND ROCKS; Their Origin, Form and Content—By Prof. Dr. F. Beyschlag, Geh. Bergrat, Direktor der Kgl. Geolog. Landesanstalt, Berlin; Prof. J. H. L. Vogt, an der Universität, Kristiania, and Prof. Dr. P. Krusch, Abteilungsdirigent a. d. Kgl. Geolog. Landesanstalt u. Dozent a. d. Kgl. Bergakademie, Berlin. Translated by S. J. Truscott, Associate Royal School of Mines, London. In Three Volumes. Vol. I, Ore-Deposits in General—Magmatic Segregations—Contact-Deposits—Tin Lodes—Quicksilver Lodes. London: Macmillan & Co., Ltd. New York: The Macmillan Co. Cloth; 6x9 in.; pp. xxviii + 514; 291 illustrations. $5, net.

The annual output of iron is of more than twice the value of any other metal produced: so far as tonnage is concerned iron is 19 times as important as all other metals combined. These and many other facts of popular interest are given in the opening chapter on the industrial status of iron. Likewise the whole book is of much more interest than its title indicates, for the author has admirably fulfilled his intention to discuss iron ores "not merely in their geologic and technical relations, but in their more general relations to industrial conditions." Consequently, the book is of value not only to mining engineers but to all engineers.

Part I, on the origin of iron-ore deposits, contains chapters on the geologic and chemical relations of iron; the iron minerals and their relationship; the formation of iron-ore deposits; sedimentary or bedded deposits; replacements and cavity fillings; alteration deposits; igneous iron deposits. Part II is on the valuation of iron-ore properties, containing chapters on the basal factors in ore valuation; prospecting and tonnage determinations; mining conditions and costs; furnace and mill requirements; composition and concentration of iron ores; ore prices, profits and markets; the effect of time on valuation. Part III treats of the iron ores of the world in 11 chapters. Part IV is on the extent and control of iron-ore reserves and contains much information of general interest. The estimated iron-ore reserves of the world are given and the bearing of these estimates upon the probable future development of the iron industry is discussed. This part of the book cannot fail to be of interest to every student of the world's progress and future, and certainly engineers should be in this class.

The second book listed above is the first of three volumes of an apparently very complete and exhaustive treatise on ore deposits of all minerals. The work is done with characteristic German thoroughness and will undoubtedly prove of the greatest value as a reference book to those readers who are unable to read the original German text, which was published in 1909.

GEOLOGICAL AND TOPOGRAPHICAL MAPS, THEIR INTERPRETATION AND USE: A Handbook for the Geologist and Civil Engineer—By Arthur R. Dwerryhouse, Lecturer in Geology in the Queen's University of Belfast. London: Edward Arnold. Cloth; 6x9 in.; pp. 133; 90 text figures. $1.25, net.

While intended primarily for the twofold purpose of those who make maps and of those who interpret maps of topographical and geological features, this little textbook contains as much geology as the average civil engineer stands much in need of. As it is an English textbook, the illustrations and conclusions are based on the British Ordnance Survey, and hence must be modified somewhat to correspond with American practice. The main part of the book is an explanation of the principles of geological formations and their representation on paper. There is also a chapter on methods of conducting a geological reconnaissance.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale, and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AIR, WATER, AND FOOD FROM A SANITARY STANDPOINT—By Alpheus G. Woodman, Associate Professor of Food Analysis, and John F. Norton, Assistant Professor of Chemistry and Sanitation, Massachusetts Institute of Technology. Fourth edition, revised and rewritten. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 248; illustrated. $2, net.

"AMERICAN EXPORTER'S" EXPORT TRADE DIRECTORY FOR 1915: A Complete List of the Export Commission Houses, Foreign Buyers, Manufacturers' Export Agents, Foreign Exchange Banks and Bankers, Marine Insurance Companies, Export Truckmen, Foreign Freight Forwarders, etc., in All the Principal United States Ports; Also Foreign Consulates in the United States, American Consulates Abroad, etc.—Compiled Under the Supervision of, and with Explanatory Notes to the Various Sections, by B. Olney Hough, Editor "The American Exporter." New York: The Johnston Export Publishing Co., 17 Battery Place. Cloth; 6x9 in.; pp. 369. $3, postage paid.

ANALYSES OF MINE AND CAR SAMPLES OF COAL COLLECTED IN THE FISCAL YEARS 1911 to 1913—By Arno C. Fieldner, Howard I. Smith, Albert H. Fay and Samuel Sanford. Bulletin 85. Washington, D. C.: U. S. Bureau of Mines. Paper; 6x9 in.; pp. 444.

ANNUAL REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY, For 1913—Washington, D. C.: War Department. Cloth; 6x9 in.; pp. 1509; illustrated.

ANNUAL REPORT OF THE DEPARTMENT OF THE INTERIOR OF CANADA (Ottawa, Ont.), For 1913, Part VIII—Annual Report of Water Power Branch for 1912-13. Paper; 7x10 in.; pp. 216; illustrated.

ANNUAL REPORT OF THE ISTHMIAN CANAL COMMISSION AND THE PANAMA ~~CANAL~~ for Fiscal Year Ended June 30, 1914. Washington, D. C.: The Commission. Paper; 6x9 in.; pp. 601; numerous plates, and accompanied by portfolio of maps and diagrams.

An abstract of this report was published in the Nov. 26, 1914, issue of "Engineering News," p. 1093.

ANNUAL REPORT OF THE NEW YORK STATE COMMISSION OF HIGHWAYS, For 1913—Albany, N. Y. Two Volumes. Cloth; 6x9 in.; pp. 602 and 221; illustrated.

ANNUAL REPORT OF THE SOUTH AUSTRALIAN RAILWAYS COMMISSIONER, For 1913-14—Adelaide, The Commissioner. Paper; 8x13 in.; pp. 48; illustrated.

ANNUAL REPORT OF THE U. S. COMMISSIONER OF PATENTS, For 1913—Washington, D. C.: Division of Public Documents. Paper; 7x11 in.; pp. 1095.

ASSAYING IN THEORY AND PRACTICE—By E. A. Wraight, M. Am. Inst. M. E., Late Senior Demonstrator in the Assaying Laboratory of the Royal School of Mines, London. New York: Longmans, Green & Co. London: Edward Arnold. Cloth; 6x9 in.; pp. xi+323; 70 illustrations. $3, net.

AUTOMATIC TELEPHONY: A Comprehensive Treatise on Automatic and Semi-Automatic Systems—By Arthur Bessey Smith, M. Am. Inst. E. E., Formerly Professor of Telephone Engineering, Purdue University, and Wilson Lee Campbell, Fellow, Am. Inst. E. E. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xii+ 407; 271 illustrations. $4, net.

CANADIAN REPORT OF PROGRESS OF STREAM MEASUREMENTS FOR 1912—Prepared under the Direction of F. H. Peters, Commissioner of Irrigation, by P. M. Sauder, Assoc. M. Can. Soc. C. E., Chief Hydrographer. Ottawa: Department of the Interior. Paper; 7x10 in.; pp. 459; illustrated.

CARRYING OUT THE CITY PLAN: The Practical Application of American Law in the Execution of City Plans—By Flavel Shurtleff, of the Boston Bar, in collaboration with Frederick Law Olmsted, Fellow, American Society of Landscape Architects. New York: Survey Associates, Inc., 105 E. 22d St. Cloth; 5x8 in.; pp. ix+349. $2, postpaid.

CHEMICAL AND BIOLOGICAL SURVEY OF THE WATERS OF ILLINOIS—Report for Year Ending Dec. 31, 1913. Water Survey Series No. 11. Urbana: University of Illinois. Paper; 6x9 in.; pp. 478.

COMPENSATION FOR ACCIDENTS TO EMPLOYEES OF THE UNITED STATES—Bulletin (Whole Number) 155. Washington, D. C.: U. S. Bureau of Labor Statistics. Paper; 6x9 in.; pp. 331.

A COMPILATION OF THE LAWS OF VARIOUS STATES on Registration and Transfer of Municipal Bonds—By the United States Mortgage & Trust Co., 55 Cedar St., New York City. Paper; 6x9 in.; pp. 41.

CONVICT LABOR ON COUNTRY ROADS: How Fulton County, Georgia, Has Solved the Convict Labor Problem—By George C. Warren, President, Warren Brothers Co., 59 Temple Place, Boston, Mass. Paper; 6x9 in.; pp. 15; illustrated.

This is a reprint of three magazine articles published recently. Besides the use of convict labor in Fulton County, Mr. Warren reviews the use of convict labor in other states and the attitude of organized labor toward the use of convicts in road work.

ELEMENTS OF FORESTRY—By Frederick Franklin Moon, Professor of Forest Engineering, and Nelson Courtlandt Brown, Professor of Forest Utilization, New York State College of Forestry, Syracuse. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xvii+392; 65 illustrations. $2, net.

EXPERIMENTS UPON THE PURIFICATION OF SEWAGE AND WATER at the Lawrence Experiment Station During 1913—By H. W. Clark and Stephen DeM. Gage. [Reprinted from the 45th Annual Report of the Massachusetts State Board of Health.] Boston: The Board. Paper; 6x9 in.; pp, 92.

FAILURE OF IRRIGATION AND LAND SETTLEMENT POLICIES OF THE WESTERN STATES—By D. W. Ross, Gen. Mgr. and Ch. Engr., Sacramento Valley Irrigation Co., Willows, Calif. (Address delivered before International Irrigation Congress, Calgary, Alta., October, 1914.) Paper; 6x9 in.; pp. 21.

After reviewing "failures" the author outlines a plan "to correct existing evils and prevent their recurrence" in the Carey Act States. An irrigation commission is proposed, under which investigations should be made and irrigation districts formed. Those receiving land allotments would be required to pay 10 to 20% of the estimated cost of reclamation at the time of entering the lands, to make sure that those who receive allotments are prepared to make use of the land. While State Engineer of Idaho, Mr. Ross had intimate experience with the workings of the Carey Act.

FOURTH ANNUAL REPORT ON THE STATISTICS OF EXPRESS COMPANIES IN THE UNITED STATES, For the Year Ended June 30, 1912—Prepared by the Division of Statistics. Washington, D. C.: Interstate Commerce Commission. Paper; 8x11 in.; pp. 42.

GAS POISONING IN MINING AND OTHER INDUSTRIES—By John Glaister, M. D., Professor of Forensic Medicine and Public Health, University of Glasgow, and David Dale Logan, M. D., Surgeon to the Coltness Iron works, Newmains. New York: William Wood & Co. Cloth; 6x9 in.; pp. xi+471; 36 illustrations, plans and colored plates. $3.50, net.

HANDBUCH DES WASSERBAUES Für Das Studium Und Die Praxis—Von Hubert Engels. In Two Volumes. Leipzig and Berlin: Wilhelm Engelmann. Paper; 8x11 in.; pp. xii+1499; 1623 text illustrations. Paper, 100 Marks. Bound (in calf) 106 Marks.

THE HUNTER RIVER FLOOD OF MAY, 1913—By H. H. Dare, Chief Engineer for Water Conservation and Irrigation, Noorebar, Victoria St., Roseville, New South Wales. [Read before the Sydney University Engineering Society, Sept. 17, 1913.] Paper; 6x9 in.; pp. 13; illustrated.

INDUSTRIAL GAS CALORIMETRY—By C. W. Waidner, Physicist, and E. F. Mueller, Assistant Physicist. Washington, D. C.: Bureau of Standards. Technologic Paper 36. Paper; 7x10 in.; pp. 150; illustrated.

LEKTRIK LIGHTING CONNECTIONS: A Waistcoat-Pocket Booklet for the Electric-Light Engineer and Contractor, the Electrician, the Wireman and the Student in Wiring Classes. With Introductory and Explanatory Notes by W. Perren Maycock, M. I. E. E., author of "Alternating Current Work." Third edition. London, England: A. P. Lundberg & Sons, 477 Liverpool Road Linen; 3x5 in.; pp. 140,; 176 text illustrations. Sixpence, net.

MATERIALS OF MACHINES—By Albert W. Smith, Director of Sibley College, Cornell University. Second edition, rewritten. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. v+215; 36 illustrations. $1.25, net.

MINNESOTA PUBLIC UTILITY RATES, GAS-ELECTRIC-WATER—Compiled in the Municipal Reference Bureau of the General Extension Division by Gerhard A. Gesell, Assistant Professor of Economics in the Division. Current Problems No. 3. Minneapolis: University of Minnesota. Paper; 6x9 in.; pp. 254.

THE MODERN FACTORY: Safety, Sanitation and Welfare—By George M. Price, Director, Joint Board of Sanitary Control in the Cloak, Suit and Skirt and the Dress and Waist Industries. New York City; formerly Director of Investigation, New York State Factory Commission. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xx+574; 257 illustrations. $4, net.

THE MOST IMPORTANT QUESTION OF THE AGE: Is the Efficiency of a Thermodynamic Reversible Cycle Independent of the Working Medium?—By Jacob T. Wainwright, P. O. Box 110, Chicago, Ill. [An Addendum to Papers having the titles: "An Investigation of the Second Law of Thermodynamics" and "The New Thermodynamics."] Paper; 6x9 in.; pp. 8.

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RAPID EARTHWORK CALCULATION—By C. E. Housden, Late of the Public Works Department of India. New York and London: Longmans, Green & Co. Linen; 5x7 in.; pp. 31; illustrated. 50c.

REPORT ON BOW RIVER POWER AND STORAGE INVESTIGATIONS, Seasons 1911-12-13—By M. C. Hendry. Ottawa: Superintendent of Dominion Water Power Branch. Water Resources Paper No. 2. Paper; 7x10 in.; pp. 345; illustrated.

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REPORT OF JOINT COMMITTEE ON VALUATION OF OHIO PUBLIC UTILITIES, Under Order No. 176 of the Public Utilities Commission of Ohio, 1914—Cleveland: Andrew P. Martin, Secretary, 620 Illuminating Bldg. Paper; 6x9 in.; pp. 42. 50c.

After the orders of the Ohio Public Utilities Commission requiring that inventories and valuations be furnished it, the several state associations of various utilities combined their efforts, through a joint committee, to make a formal statement of principles to be followed. The statement finally agreed upon is fairly brief and follows the method of "reproduction cost new less depreciation." The report defines (1) property used and useful, (2) reproductive cost, (3) period of theoretical production, (4) working capital, (5) unit costs, (6) overhead costs, (7) apportionments, (8) depreciation methods, and (9) depreciation reserves. The report also gives an inventory outline and explains the various items.

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THE SALEM FIRE—By Arthur B. Jones, Ex-Assistant Fire-Chief of Salem, Mass. Boston: The Gorham Press. Cloth; 5x8 in.; pp. 137; illustrated. $1.

SOME CONSIDERATIONS REGARDING CAST IRON AND STEEL PIPES—By John Sharp, M. I. Mech. E., author of "Modern Foundry Practice." New York and London: Longmans, Green & Co. Cloth; 6x9 in.; pp. viii+142; 21 illustrations. $1.50, net.

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